RD INSTRUMENTS

FOR RESEARCH AND DEVELOPMENT

# INSTRUCTION MANUAL

*for*

# MODEL KS-15874-L2
# CARDMATIC TUBE TESTER
**with Serial Numbers Above 900**

THE HICKOK ELECTRICAL INSTRUMENT COMPANY • 10514 Dupont Avenue, Cleveland 8, Ohio

# MODEL KS-15874-L2
# CARDMATIC TUBE TESTER
**with Serial Numbers Above 900**

## STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment, to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture, used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

## RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue, Cleveland 8, Ohio, or to the authorized service station designated.

## REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

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Code No. 2490-417


Figure 1 - KS-15874-L2 Tube Tester

# MODEL KS-15874

## CARDMATIC TUBE TESTER

### 1. GENERAL

1.01 This book describes the KS-15874 Electron Tube Tester and gives the methods for operating and maintaining the set.

1.02 This tube tester is for general Bell System use. It is capable of testing practically all small sized, low power tubes of Western Electric Company or other manufacture.

1.03 The set is manufactured by The Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland 8, Ohio.

1.04 The set is semi-automatic in operation. Testing of tubes is done by selecting and inserting a punched card which automatically programs test conditions. This is in lieu of roll charts and manual selectors which were used on previous testers.

1.05 Dynamic tests are performed under conditions which are as close as possible to the operating condition of the tube rather than a common operating point as was formerly done.

## 2. DESCRIPTION

### A. General

2.01 The KS-15874 Tester is self-contained in a portable aluminum carrying case with removable cover. The outside dimensions of the case are approximately 19-1/2 inches wide by 9-1/2 inches high by 16-1/2 inches deep. The weight is about 42 pounds.

2.02 In the test set case there is a compartment which contains program cards for testing Western Electric tubes.

2.03 The cover of the tester case contains brackets for storing an instruction book, the power cord, a calibration cell for checking the meter and short test, calibration cards, 50 hand punch cards and a hand punch.

### B. Description of Front Panel

2.04 The front panel is shown in Figure 2. The largest feature is the card switch which has a receptacle for receiving the program cards. When a pre-punched card is fully inserted into the switch it actuates a micro-switch which in turn actuates a solenoid to move the card switch contacts to complete the circuit. When the card switch actuates, the large knob at the left of it pops up. This PUSH TO REJECT CARD knob must be pressed to open the switch contacts and release the card. The card switch actuates only when a card is in the proper position and operates on the principle that absence of a hole in the card makes a contact.

2.05 The meter contains four scales. The upper scale is graduated from 0 to 100 for direct numerical readings. The three lower scales numbered 1, 2 and 3 are read for LEAKAGE, QUALITY and GAS respectively. Each numbered scale contains green and red areas marked GOOD and REPLACE.

2.06 Inside the small hood, directly in front of the meter, are five neon lamps which indicate shorts between tube elements.

2.07 A push button, marked 2, is used for transconductance, emission, and other quality tests which are described later. In general when this button is pressed, results are read on scale 2 of the meter.

2.08 Another button, marked 3, is used for making grid current measurements which result when gas is present in the tube vacuum. Results of this test are read on scale 3 of the meter. This button is interlocked with button 2.

2.09 A button marked 4 is used for tests of dual tubes in which both halves are alike. A neon lamp lights when button 4 is to be used.

2.10 Eleven sockets which will take all common tubes plus pin straighteners for the 7 and 9 pin miniature tubes are on the panel.

2.11 Power is turned on and off by slave relay, K101, which is controlled by two push-buttons on the main panel. BLACK for power ON. RED for power OFF. A pilot light appears next to these switches.

2.12 In the area near the ON-OFF switches there are five fuses. Three of these fuses are paired with neon lamps to indicate when they have blown. These three fuses protect portions of the circuit which are not protected by other means. The remaining two fuses protect both sides of the main power line.

2.13 Brief operating instructions also appear on the front panel.

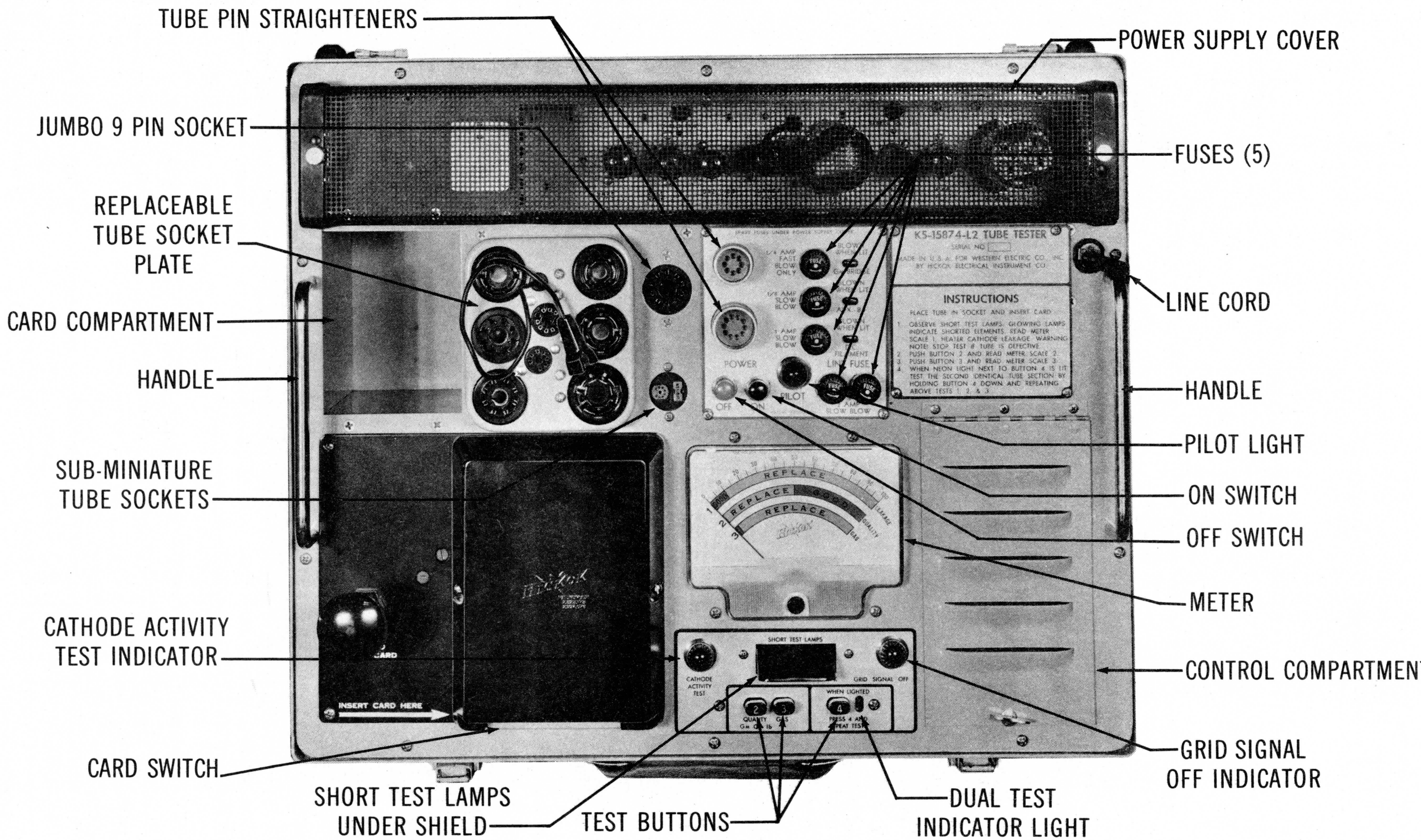



Figure 2 - Identification of Controls and Components

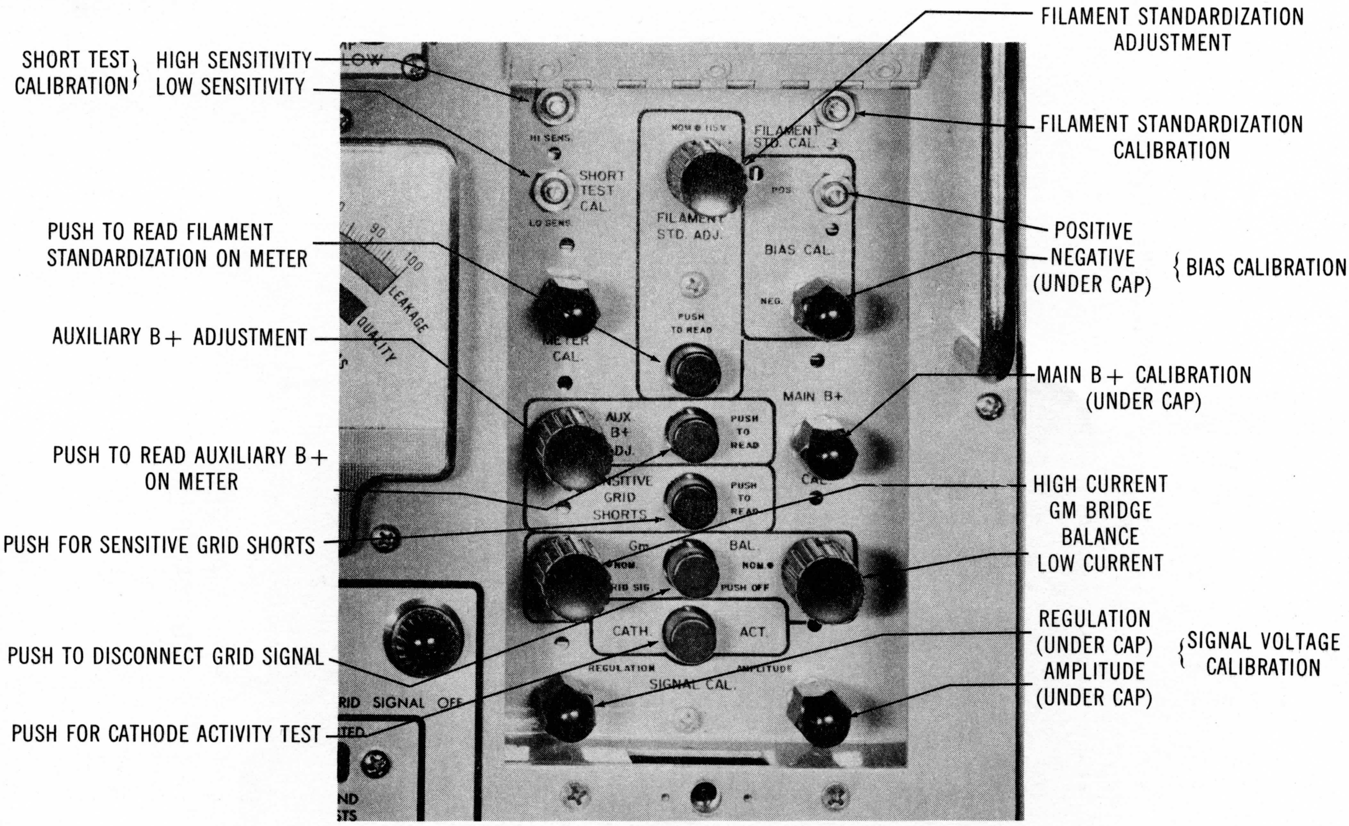



Figure 3 - Auxiliary Compartment

C. Auxiliary Compartment

2.13 A hinged panel covers a group of auxiliary controls which are used for special tests and for calibration of the set.

2.14 Two of these controls marked SIGNAL CAL. are used with special test cards for adjusting the REGULATION and AMPLITUDE of the signal voltage.

2.15 A push button marked CATH ACT is used for making cathode activity tests. When this button is pressed the filament voltage is reduced 10 percent. Results of the test are read as a change in reading on the numerical meter scale. As a warning to the operator, when the CATH ACT button is pressed, a lamp on the main panel is lighted.

2.16 A push button and two potentiometers are used for balancing the Gm bridge circuit under actual tube operating current for any Gm test. When the button is pressed it removes the grid signal and allows a zero balance to be made with one potentiometer or the other depending on whether the tube under test is passing HI or LO plate current. A lamp on the main panel is lighted when this adjustment is being made.

2.17 A button labeled SENSITIVE GRID SHORTS is used for checking grid to cathode shorts at a sensitivity much higher than the normal tests. The results of this test are observed on the short test lamps.

2.18 Certain special tests require the use of a continuously adjustable auxiliary power supply. By pressing the PUSH TO READ button the meter is used to monitor the voltage of the auxiliary power supply. This voltage may be adjusted by the use of the potentiometer labelled AUX B+ ADJ.

2.20 The rest of the potentiometer controls, marked MAIN B+ CAL, BIAS CAL NEG. BIAS CAL POS, FILAMENT STD CAL, METER CAL, SHORT TEST CAL, HI SENS, SHORT TEST CAL LO SENS, are calibration controls and are adjusted by the use of special calibration cards and a calibration cell, as covered in the section on routine calibration and also the maintenance section of this book.

2.21 The line voltage to the tester may vary over a wide range. All circuits in the tester are electronically regulated except the filament supply. To correct for this, a button is pressed and the FILAMENT STD ADJ switch is rotated until the meter reads midscale.

D. Program Cards

2.22 The circuitry in the tester which is to be utilized is selected by a pre-punched card. These cards are made of a tough vinyl plastic material.

2.23 The card switch in the tester has 186 single pole single throw switches. These are arranged in 17 rows with 11 switches in each row. The vinyl card is used to push the switches closed and therefore the absence of a hole in the card is required to actuate a switch.

2.24 The tube numbers are printed in color on the tabs of the cards. For convenience in the filing system the tube number is also printed at the edge of the card.

2.25 The cards are arranged in alpha-numerical order in the test compartment. A special card is provided to be used as a marker when a card is removed for use.

2.26 A pack of calibration cards is supplied for use in routine calibration of this equipment. Another pack of cards is included for use in trouble shooting and complete calibration.

2.27 A pack of printed blank cards and a hand punch are provided so that additional tube test cards may be punched as new tubes are developed. Torn, broken or unserviceable cards may be replaced or duplicated with the hand punch and blank cards.

## 3. CALIBRATION

3.01 General. The tester is equipped with self-calibrating features which include calibration controls located in the auxiliary control compartment and corresponding calibration code cards. The calibration procedures are divided into two parts, Routine Calibration, listed below, and Complete Calibration, listed in the Maintenance Section.

3.02 Routine Calibration is quickly performed using the proper calibration cards and does not require external test equipment. It should be performed upon initial installation, after the first week of operation, and at least once a month thereafter.

3.03 Complete Calibration is also performed with the use of special calibration cards, however, additional test equipment is required for some of the checks.

3.04 The complete calibration may be performed at the time of installation, (in addition to Routine Calibration noted above), and should be checked at least twice a year and whenever trouble is suspected or maintenance work has been performed.

3.05 Routine Calibration Procedure.

a. Turn tester on and allow it to warm up for 25 minutes. Check that the meter is reading zero. If necessary, re-adjust the mechanical zero adjust so that the needle knife-edge rests over the zero line.

b. Select the Routine Calibration Cards, #1 through #10, from the tester case cover.

3.06 Meter Check.

a. Insert calibration card #1, METER, into the switch. Plug the calibration cell into the octal test socket, see figure 4. (The calibration cell is normally stored in the cover of the tube tester.) The left short lamp will glow.

b. Press button #2 for check of meter microamp cal. The meter should read within ± 1 division of the figure written in the top blank on the calibration cell cover. If the reading is out of tolerance the meter should be checked against a meter standard for 50 $\mu$amp indication at mid-scale. If the error is significant, the meter should be repaired or replaced.

c. Hold down button #2 and press button #4 to check meter millivolt sensitivity. The meter should read within ± 1 division of the figure written in the bottom blank on the calibration cell cover. If the reading is out of tolerance, adjust the "METER CAL" control for proper reading.

NOTE: Routine Calibration Controls are located in the auxiliary control compartment. If the control has a protective cap, its setting should be rechecked after the cap is replaced.

3.07 Short Test Sensitivities.

DURING THE FOLLOWING FOUR TESTS (CARDS #2 THRU #5) LEAVE THE CALIBRATING CELL IN THE OCTAL SOCKET. DO NOT PRESS ANY BUTTONS.

a. Insert Calibration Card #2, SHORTS 2 MEG NO-GO. Observe that no short lamps are lighted. If any lamps are glowing adjust "LO SENS" short test control to just extinguish all lamps.

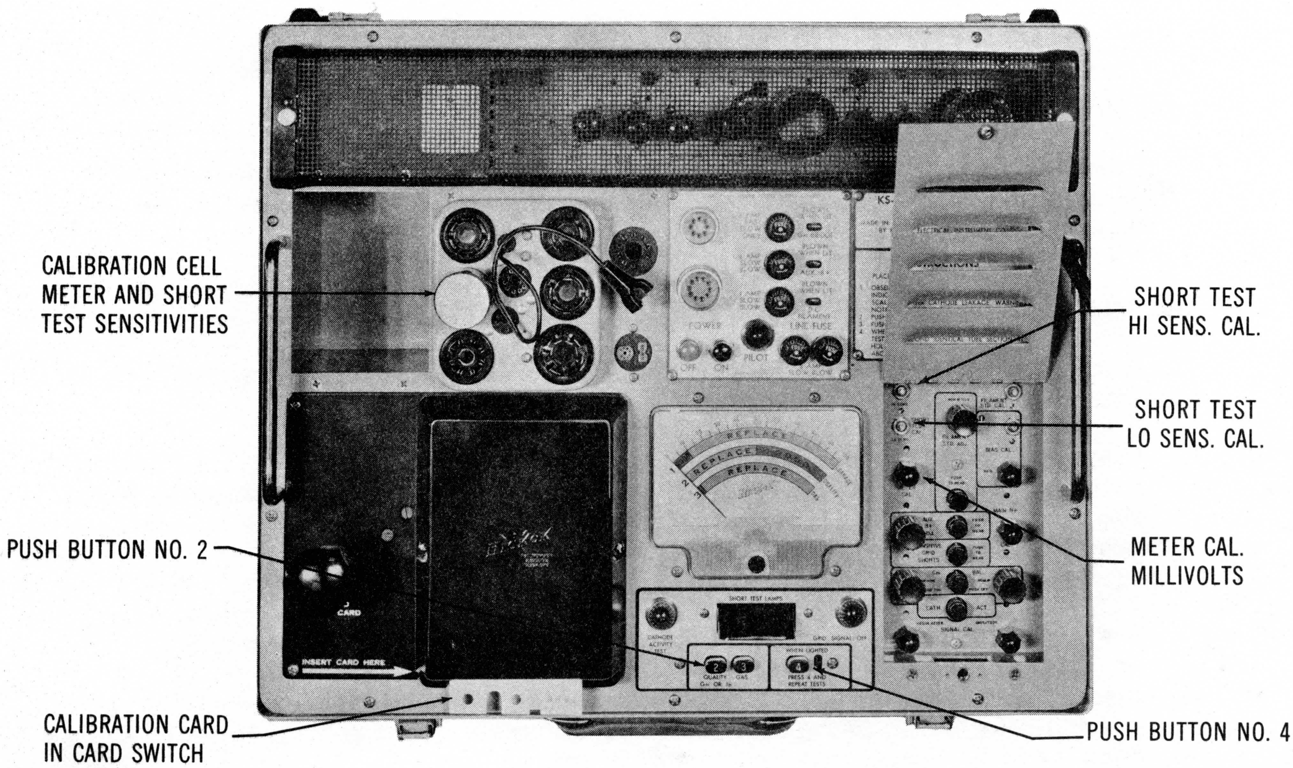



Figure 4 - Meter Sensitivity

b. Insert Card #3, SHORTS 1 MEG GO. The left four lamps should glow. If they are not glowing re-adjust the "LO SENS" control until they glow with Card #3 and are extinguished with Card #2, as listed above.

c. Insert Card #4, SHORT 20 MEG NO-GO. Press SENSITIVE GRID SHORTS button located in the Auxiliary Compartment (See Figure No. 3). No short lamps should glow. (If any are lighted adjust the "HI SENS" control).

d. Insert Card #5, SHORT 10 MEG GO. Press SENSITIVE GRID SHORTS button located in the Auxiliary Compartment (See Figure No. 3). The number 4 lamp only (counting left to right) should glow.

NOTE: The Lamp may flicker or glow dimly as compared to the "LO SENS" short indication. If the number four lamp is not glowing re-adjust the "HI SENS" control until it glows with card #5 and is extinguished with card #4, as before.

REMOVE CALIBRATION CELL FROM OCTAL SOCKET.

3.08 Bias Calibration.

a. Insert Card #6, FIXED BIAS CAL NEG. No short lamps should glow. Press button #2. Meter should read half scale. If reading is other than half scale, adjust "BIAS CAL NEG" control for proper indication.

b. Insert Card #7, FIXED BIAS CAL POS. Short lamps 1 and 2 should glow. Press button #2. Meter should read half scale. If another reading is obtained, adjust "BIAS CAL POS" control.

3.09 Main B+ Power Supply Calibration.

a. Insert Card #8, MAIN B PLUS CAL. Short Lamps 1, 2, 3 and 5 should glow. Press button #2. The meter should read half scale. If meter reading is not proper, adjust MAIN B+ CAL for correct indication.

3.10 Gm Bridge Balance.

Check that the white dots on the Gm BAL HI Ib and LO Ib knobs are in line with the associated dots labeled NOM (Nominal) on the panel.

a. Insert Card #9, GM BAL LOW IB. Press button #2. Meter should read zero, +5 divisions or minus the equivalent of 5 divisions. If the reading is out of tolerance the LO Ib control may be adjusted for a zero reading and the knob re-set on the control shaft to properly align the dots.

NOTE: The balance adjustments are somewhat subject to temperature variation and the tester should be completely warmed up prior to these adjustments.

b. Insert Card #10, GM BAL HI IB. Press button #2. The meter should read zero, + 5 divisions or minus the equivalent of 5 divisions. If the reading is out of tolerance the HI Ib control may be adjusted in manner noted for LO Ib above.

## 4. OPERATION

### A. Normal

4.01 Before operating this set the calibration procedure, as outlined in Section 3.0 should be followed.

4.02 The tester is equipped with a three-conductor power cord, one wire of which is chassis ground. It should be plugged into a 105 to 120 volt 60 cycle outlet having a building ground.

4.03 Open the auxiliary compartment trap door and check for the following to be in the NOM position:

FILAMENT STD. ADJ. knob
GM BAL - 2 knobs. GRID SIG. button should be up, no red light at GRID SIGNAL OFF lamp.
CATH ACT - Button up and no red light at CATHODE ACTIVITY TEST lamp.

All other controls in this compartment should be left as is.

4.04 Turn on the tester and allow it to warm up for 5 or 10 minutes. This tester may be left on for extended periods without harm. Some heat will be noted from the ventilated section at the rear but this is normal.

4.05 Press PUSH TO REJECT CARD knob down until it locks and remove the non-test card from the switch. This card is used to keep the switch pins in place during the shipment and should be inserted before transporting the tester.

4.06 Plug the tube to be tested into its proper socket. Pin straighteners are supplied for 7 and 9 pin miniature tubes and should be used before these tubes are plugged in.

4.07 The tester is shipped with cards for Western Electric tubes in its case. Cards for commercial tubes are obtained separately. It is important that cards be kept in their proper order. A yellow plastic flag is provided to be used as a book mark when cards are removed. It is expected that different locations may want to add more markers to separate card groups or to intermix Western and commercial cards in the tester case. However, this should be done with care so that other operators will not be confused. Probably it would be best to use the tester a few months before any refiling is done.

4.08 Select the proper card (or cards) for the tube to be tested. Insert the selected card into the slot in the card switch until the card switch is actuated. This is indicated when the PUSH TO REJECT CARD knob pops up.

NOTE: The card will operate the tester only when it is inserted properly, that is, when the printing is up and toward the operator. Never put paper or objects other than program cards into the card switch as they may jam the switch contacts. If the overload relay shuts off the tester when the program card actuates the card switch, check to make sure that the proper card is being used or if the tube under test has a direct interelectrode short.

Once the card switch has been actuated the tube under test is automatically subjected to an interelement shorts test and a heater to cathode leakage test. A blinking or steady glow of any of the short test lamps is an indication of an interelement short. If the short test lamps remain dark, no interelement shorts exist within the tube under test. If an interelement short exists between two or more elements, the short test lamp or lamps connected between these elements will remain dark and the remaining lamps will light. The abbreviations for the tube elements are located on the panel just below the short test hood so that the neon lamps are between them, making it possible to determine what elements are shorted. For example, if all the lamps were lighted except the right hand one it would indicate a grid to cathode short. If only the left hand

lamp is lighted it indicates a plate to cathode short. Heater to cathode shorts are indicated as leakage currents on the number 1 meter scale. If the meter reads above the green area the tube should be replaced. A direct heater to cathode short would cause the meter to go full scale.

4.09 The tube is now ready for the QUALITY test. This may be for transconductance, emission, plate current, voltage drop, etc., depending on the type of tube being tested. Push the number 2 button and read the number 2 meter scale which tells whether or not the tube is good. The actual Gm or milliampere reading can be interpreted with the aid of the TUBE TEST CONDITIONS booklet which is shipped with the tester. When the number 2 button is pressed the numerical meter scale may be read as a percentage of full scale. By referring to the booklet for the full scale reading the actual Gm can be determined. For example, if a tube read 70 and the booklet listed its full scale reading as 6800 umhos, the actual reading would be 70% of 6800 or 4760 umhos. Of course the reading for rectifiers and diodes would be interpreted in milliamperes instead of micromhos.

4.10 The tube may be checked for gas by pressing the number 3 button and reading the number 3 meter scale. The number 2 button also goes down when 3 is pressed.

4.11 If a tube such as a dual diode or dual triode which has two identical sections is being tested, the neon lamp next to the number 4 button will light. This lamp tells the operator that he may check both sections with one card. To do this the operator checks the tube for shorts, leakage, quality and gas which takes care of one section. He then holds down button 4 and repeats the checks for shorts, leakage, quality and gas on the second section.

4.12 Some tubes require more than one card. For example, a tube having dual diode sections and a triode section would have two cards, one for the triode and one to be used with button 4 for checking the diodes. If the two diode sections were not alike the tube would take three cards and the lamp by button 4 would not light. Some tubes have more than one card so that special tests may be made. Commercial voltage regulator tubes have four cards. The first card is an instruction card. The second card is for the dark current test or the point just below firing when the tube is at the maximum leakage point. Button 2 is pressed for this test but leakage is still read on the number 1 meter scale. Card 3 is the low current test. It flows minimum current through the tube and measures the voltage across the tube. Card 4 is the high current test. It flows maximum current through the tube and measures the voltage across the tube. The difference between the readings with cards 3 and 4 indicates the regulation ability of the tube. The closer the readings, the better the regulation.

## B. Auxiliary Tests

4.13 As seen from the foregoing paragraphs the normal testing procedure is extremely simple. All that is necessary is to insert the card, check shorts and leakage and then press two buttons and take readings. However, there are other tests which can be made. Controls for these are located in the auxiliary compartment. This compartment has been described in paragraphs 2 and 3 in detail. For testing tubes the only controls used are the five push buttons and the four knobs associated with them. Actually two of these (FILAMENT STD. ADJ. and Gm BAL.) are not really tests but are controls to obtain more accurate test results.

4.14 The FILAMENT STD. ADJ. controls the primary side of the filament transformer. It is used to compensate for variations in line voltage and for variations caused by tubes having large filament currents. For all tubes the white dot on the knob may be aligned with the dot labelled NOM. and left there. However, when the operator wishes to obtain very accurate tests the filament voltage may be standardized for every tube. To do this the PUSH TO READ button is held down and the knob is rotated until the meter reads as close to 50 as possible. When the operator has finished testing tubes, he should restore the knob to NOM.

4.15 The complete adjustment of the Gm bridge balancing controls is described in 3.0. To obtain the most accurate results, the balance should be checked every time a tube is tested for Gm. To do this press button 2 and the GRID SIG. button. The GRID SIGNAL OFF lamp on the tester panel will light. Adjust the LO Ib or HI Ib knob until the meter reads as near zero as pos-

sible. Most tubes require the adjustment of the LO Ib knob, however, tubes that draw heavy plate current require the adjustment of the HI Ib knob. After completing the check, restore the GRID SIG. button to normal by pressing any other button in the auxiliary compartment. When the operator is finished testing he should return both balance knobs to their NOM. positions.

4.16 The cathode activity test is used as an indication of the amount of useful life remaining in the tube. By reducing the filament voltage ten percent and allowing the cathode to cool off slightly the ability of the cathode as an emitter of electrons can be estimated. This test is made in conjunction with the normal quality test. After the tube has warmed up button 2 is pressed and the test meter is read on scale 2; also the numerical reading on the 0-100 scale is noted. The CATH. ACT. button is then locked down. A red light on the tester panel comes on. After a wait of about 1-1/2 minutes button 2 is again pressed and the reading taken on the numerical scale. The tube should be rejected if this reading differs from the normal reading by more than 10 percent or if the reading drops into the red area on scale 2. After this test the button should be restored to normal by pressing any other push button in the auxiliary compartment.

4.17 It is often desirable to check tubes for shorts between grid and cathode at a sensitivity greater than normal. This is especially true for tubes used in oscilloscopes and television sets. To make this check merely press the SENSITIVE GRID SHORTS button and note carefully if any of the shorts lamps light.

4.18 The remaining control in the auxiliary compartment is the auxiliary B+ adjustment. This control varies the voltage of the auxiliary regulated supply. This supply is only used on special test cards such as for Western Electric cold cathode and voltage regulator tubes.

C. Hand Punch Card System

4.19 The Hickok hand punch card system consists of fifty printed blank cards, and one steel hand punch. Additional cards may be ordered under the Hickok Part No. 3122-80.

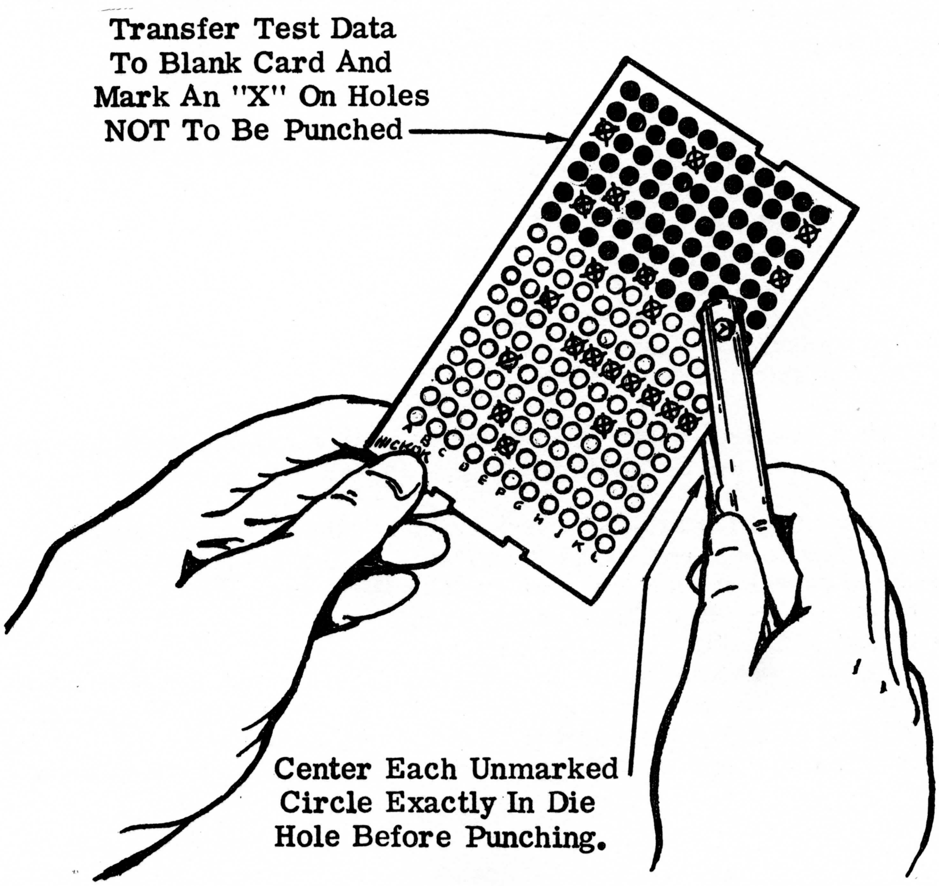



Figure 5 - Punching New or Replacement Tube Test Code Cards

4.20 Preparation of Cards: The Hickok CARDMATIC switch is designed so the unpunched areas in a test card close the contacts. Therefore, all the circles are punched in the card except the ones that close circuit switches.

a. Transfer the test data to the blank card and mark an "X" on the circles not to be punched.

b. A convenient way to locate the correct circles on the card is to find the desired lettered row and mark the circles that are not to be punched in that lettered row.

4.21 Punching the Card: Locate the unmarked circle exactly in the die hole of the hand punch and punch the hole.

4.22 Replacing Broken Cards:

a. Place the parts of the broken card over a blank card and mark the holes to be punched.

b. Center the marked circles in the die hole of the hand punch and punch the holes.

## 5. CIRCUIT

### A. Circuit Theory

5.01 Previous testers have checked tubes with circuits which were fixed in nature. When a tube having characteristics different from any other was developed it was necessary to test it on a compromise type circuit. In the KS-15874 Tester an effort has been made to include enough separate circuits so that by interconnecting them, nearly any tube may be tested for nearly any condition. The feature which makes this possible is the card switch with its 186 contacts. This switch may be thought of as a group of patch cords to interconnect a group of laboratory components. This group of components contains the following:

1. 1% R box - high current
2. 1/4% meter
3. 1% meter shunt system
4. Black box - direct reading Gm
5. Fixed bias supply - 1%
6. Regulated B+ supplies
7. AC supplies
8. Decade filament supplies
9. Regulated signal
10. A group of capacitors

5.02 The card switch connects these components in nearly any configuration rather than following a fixed circuit pattern. Its functions are mainly as follows:

It applies the properly established voltages to the various pins of the tube sockets.
It chooses a high wattage decade resistance from 0 to 70,000 ohms, in 10 ohm setps
It places certain fixed capacitors into the desired point in the circuits
It puts the Gm bridge into the proper point of the circuit
It connects the regulated signal of 222 millivolts
It chooses half-scale meter shunts capable of resolving at mid-scale, Gm's of 250 to 13,000 micromhos in 50 micromho steps; 250 to 64,000 micromhos in 250 micromho steps; currents from 50 to 2600 microamps in 10 microamp steps; and from 1 to 255 milliamps in one milliamp steps; or voltages from 5 to 260 volts in one volt steps.

It places the meter and its shunts at the proper point of the test circuit.
It applies a high current, 500 volts AC supply, to the proper point of the test circuit.
It applies a regulated DC supply to the proper point in the circuit and selects its voltage from 10 to 250 volts in 10 volt steps.
It controls a decade fixed bias supply for bias voltages from 0 to 100 volts in 0.1 volt steps.
It chooses a decade filament voltage from 0 to 119.9 volts in 0.1 volt steps.

5.03 In this tester an effort has been made to test tubes under typical operating conditions and values recommended by tube handbooks. Instead of only Gm and emission tests being used, variations have been added to compliment them. Some examples of how the circuit selection system is used in testing various types of tubes are explained in the following paragraph.

5.04 The amplifying type tubes, which are those having control grids, are tested for Gm. Most of these are in the triode and pentode groups. Triodes are usually operated in either a fixed bias or self-bias circuit. Figure 6 illustrates that for triode fixed bias types the cathode is ground. The negative bias plus a small A.C. signal is added and applied to the grid. The plate of the tube is connected to one end of the Gm bridge circuit with the regulated DC or B+ connected to the other end. This circuit is set up by the card in the card switch and by pressing button 2 it is energized for the test.

Figure 6 shows that the triode self bias test resembles the fixed bias test except that the cathode is grounded through the biasing resistance which is shunted by a capacitor.

5.05 By referring to Figure 6 it is noted that pentodes are tested the same as triodes except for the addition of the screen and suppressor grids. In both cases the screen voltage is connected just before entering the Gm circuit. In fixed bias operation the suppressor grid is grounded directly while in the self bias case it is connected to the cathode.

5.06 Figure 7 shows a two-control grid type of heptode. In testing this tube the bias voltage is applied to each control grid but the signal is only applied to one at a time, which then makes a measurement of the respective grid to plate Gm. Two test cards are necessary for this type of tube.

5.07 Power pentodes used in pulse applications are given a normal Gm test but in addition receive a second test which is referred to as a "knee" test. In order to produce the necessary pulse power the plate current of these pentodes must sweep from near cut-off to full saturation at the knee of the plate current-plate voltage curves. The Gm test is important but the knee test is necessary for a complete check. The "knee" test circuit is shown in Figure 7.

5.08 Figure 7 shows two special tests that are made for triodes intended for computer application. In addition to the normal Gm test these tubes are normally tested for zero bias plate current (ON test) and for high bias plate current (OFF test). Since these tubes are intended for multivibrator application it has been found necessary to make these tests to assure proper operation.

5.09 DC Filament Tubes. Certain battery-operated tubes have directly heated or filamentary cathodes. These are tested the same as triodes or pentodes except in certain cases dc from the full wave silicone rectifier bridge is applied to the filament of the tube. Should shorts occur in this type of tube, the meter will deflect to the left under the leakage test. This can be disregarded as the shorts lamps will actually show the defect.

5.10 Diode type tubes are tested with several different circuits depending on the type of diode tested. In the full wave rectifier circuit shown in Figure 8, the 250 volt center tapped ac is applied directly across the plates of the tube. A load resistance with filter capacitor is connected to the cathode of the tube. The output current is measured by the meter being connected as a dc milliammeter. The load resistor is adjusted so that the average indicated current or emission will be for the handbook condition.

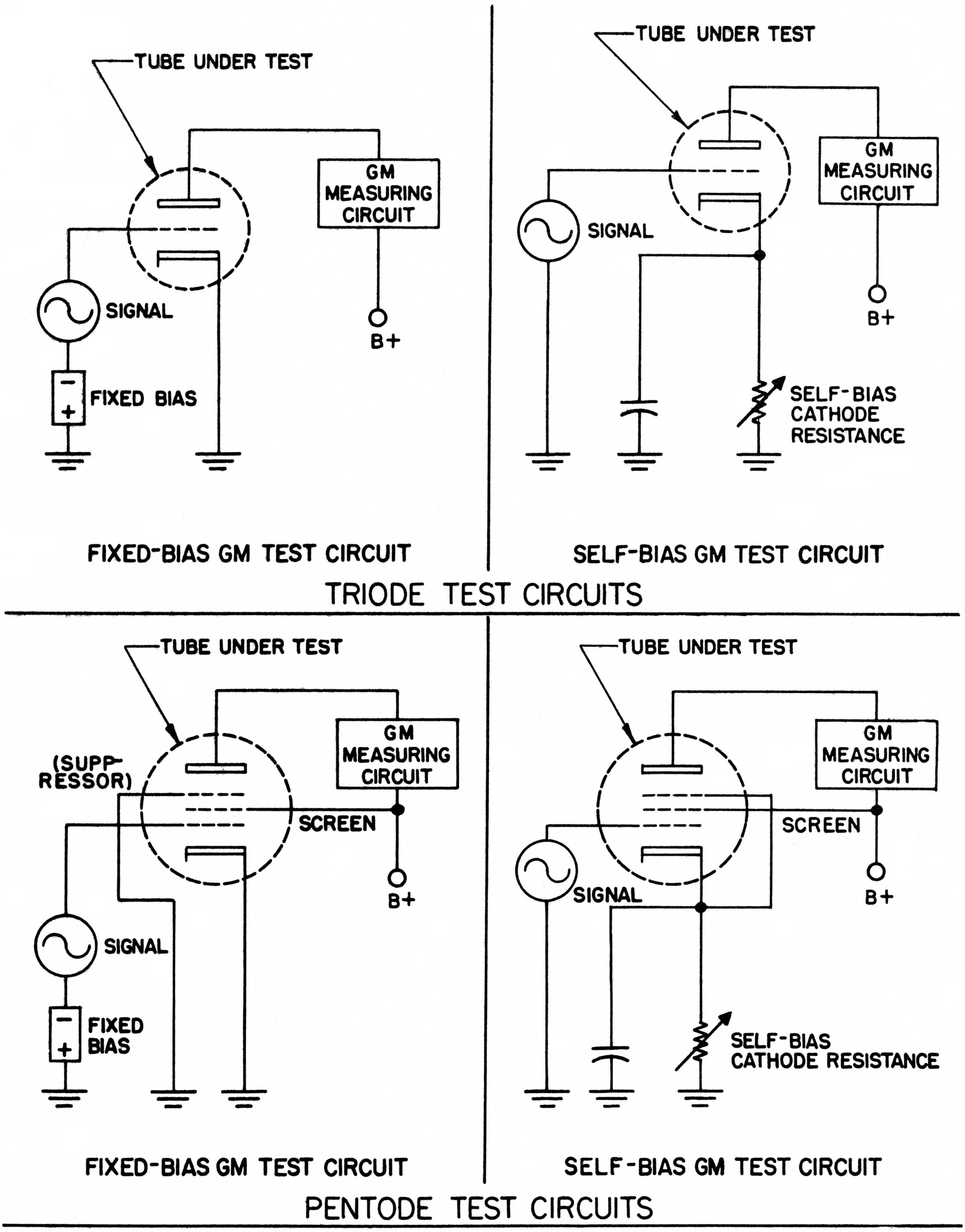



Figure 6 - Test Circuits for Amplifying Tubes

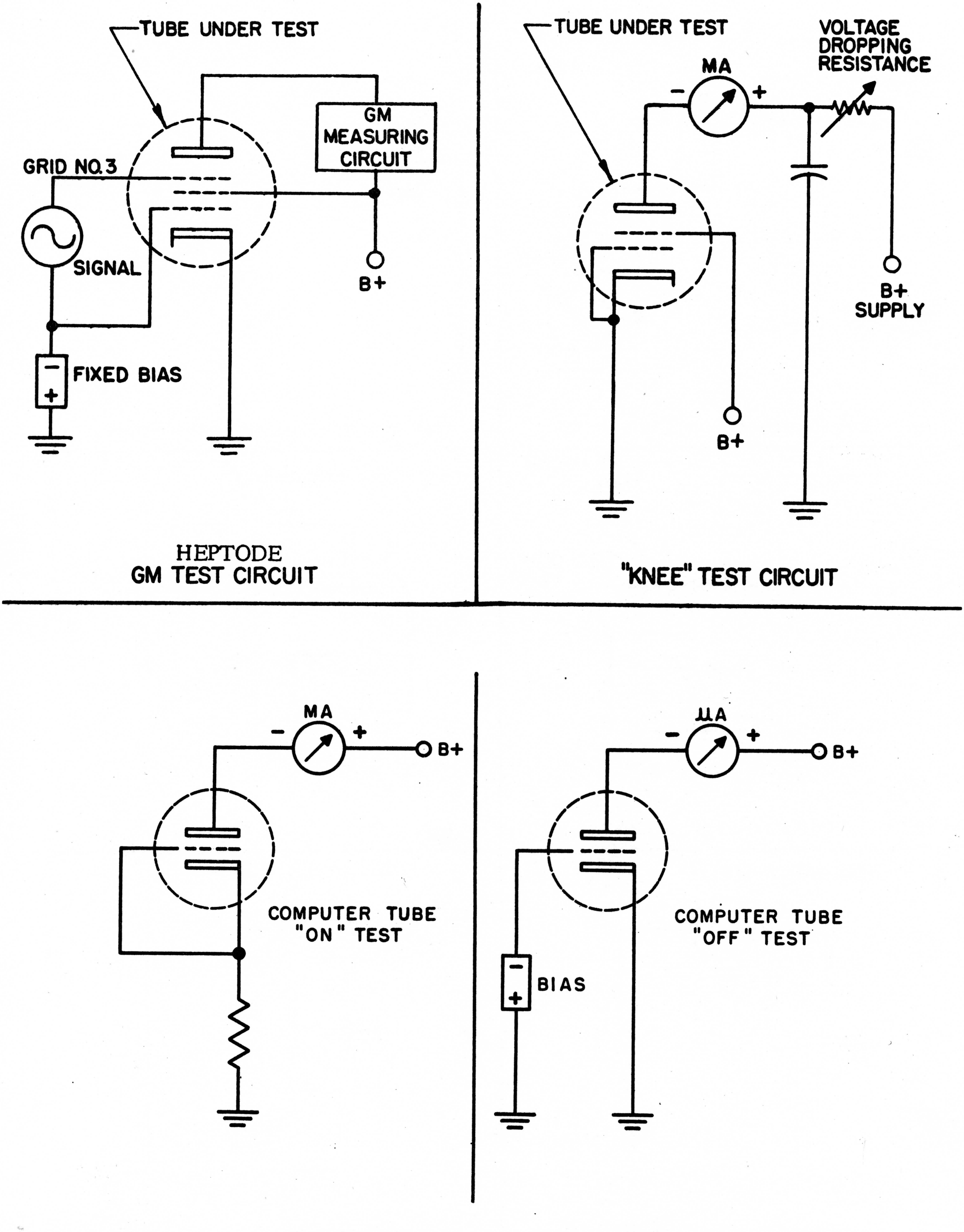
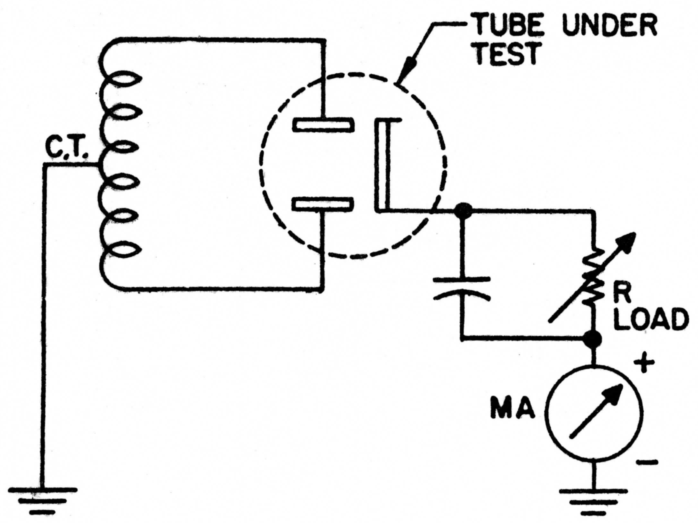
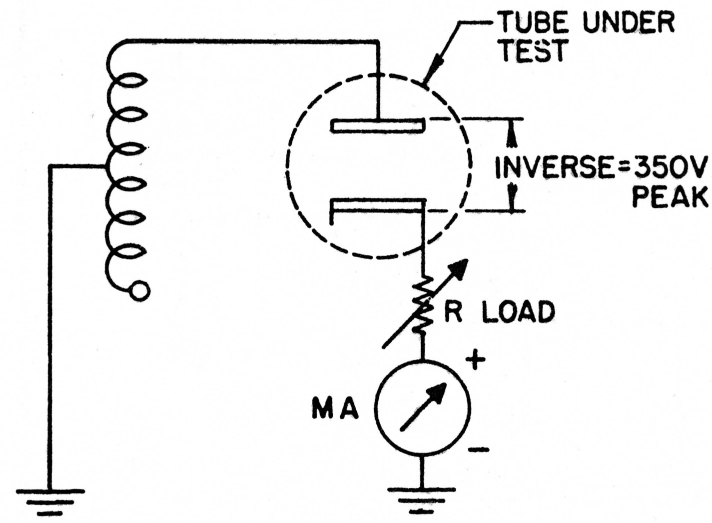


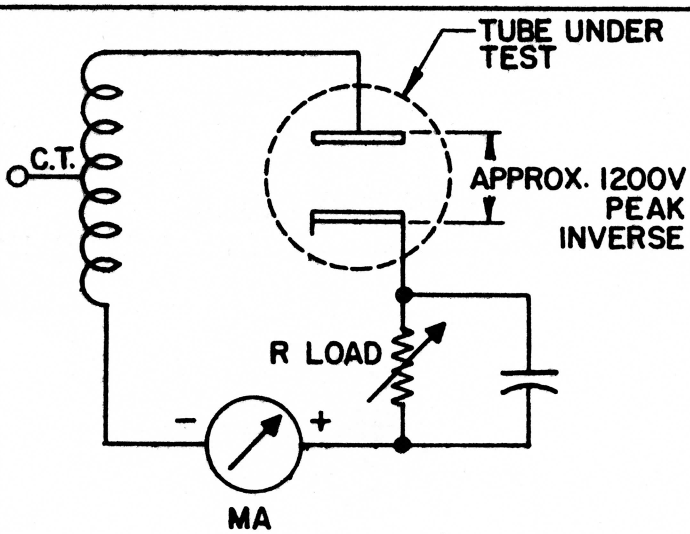

Figure 7 - Special test Circuits



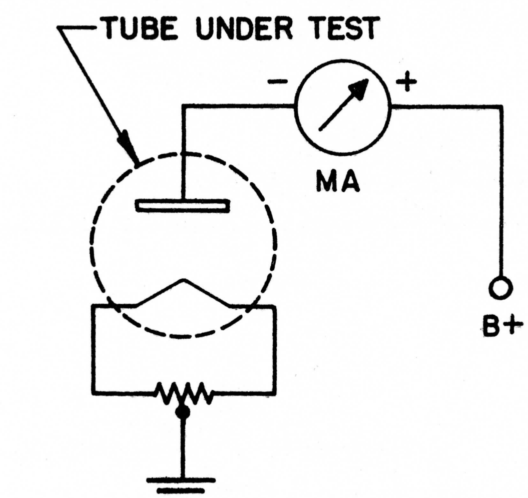

Full Wave Rectifier Test Circuit



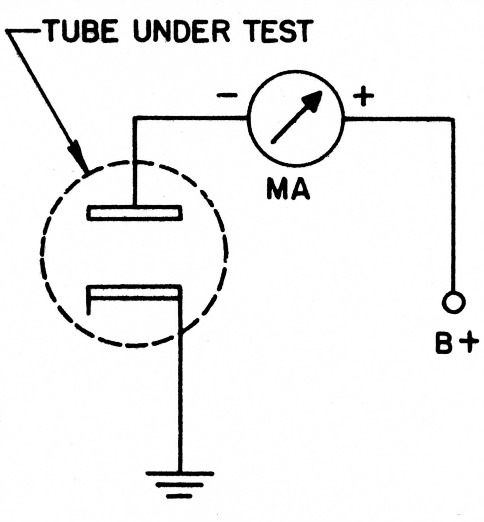

Half Wave Rectifier Test Circuit



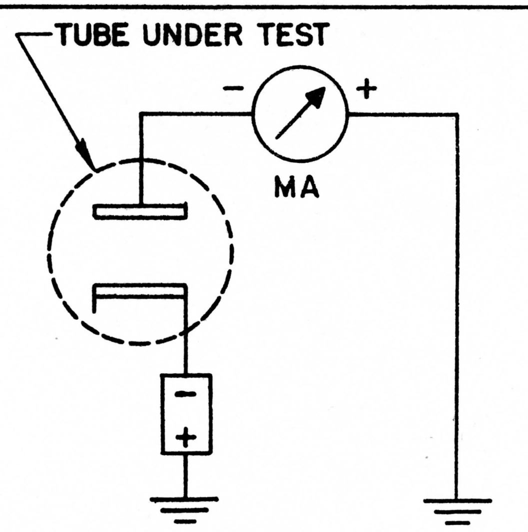

High Voltage Rectifier Test Circuit




High Voltage Diode Test Circuit

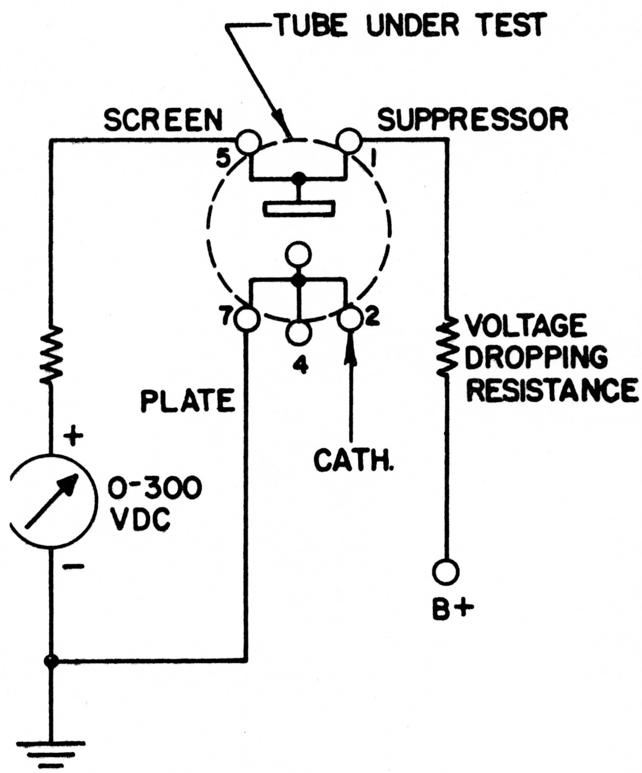



High Perveance Diode Test Circuit

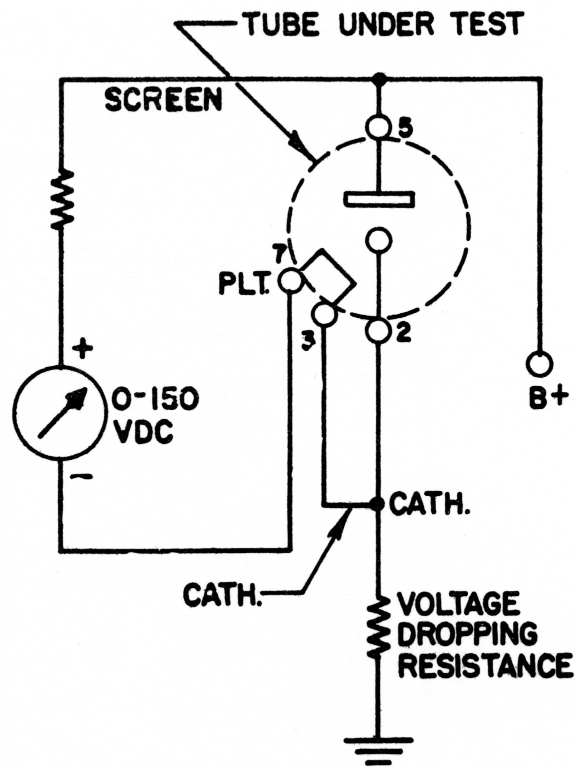



Low Perveance Diode Section Test

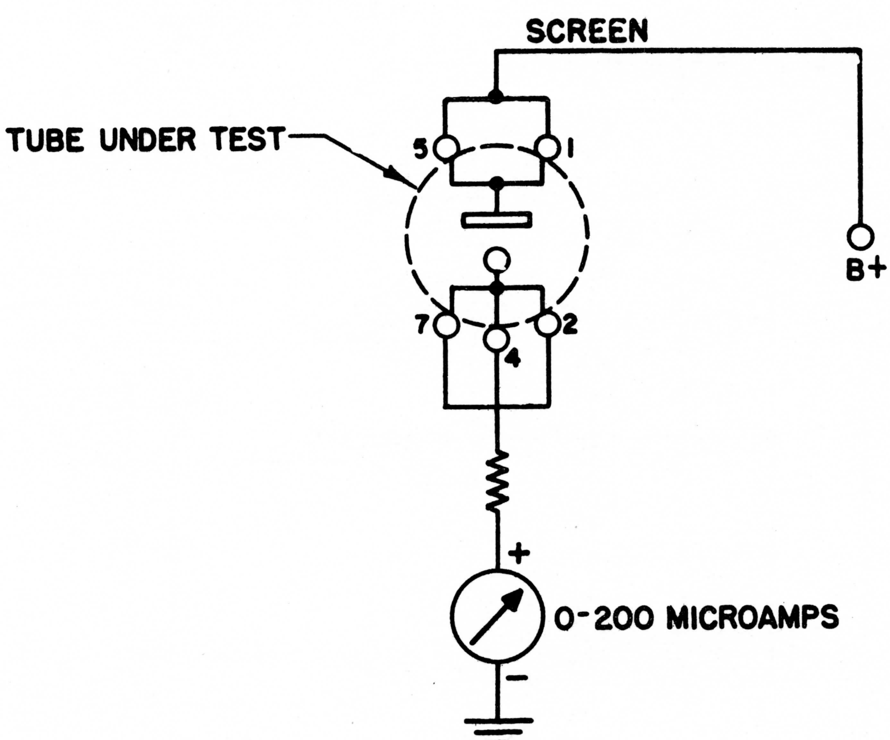
Figure 8 - Basic Types of Diode Test Circuits




OA2 TEST CIRCUIT




OA3 TEST CIRCUIT




OA2, OB2 LEAKAGE TEST CIRCUIT

Figure 9 - Voltage Regulator Test Circuits

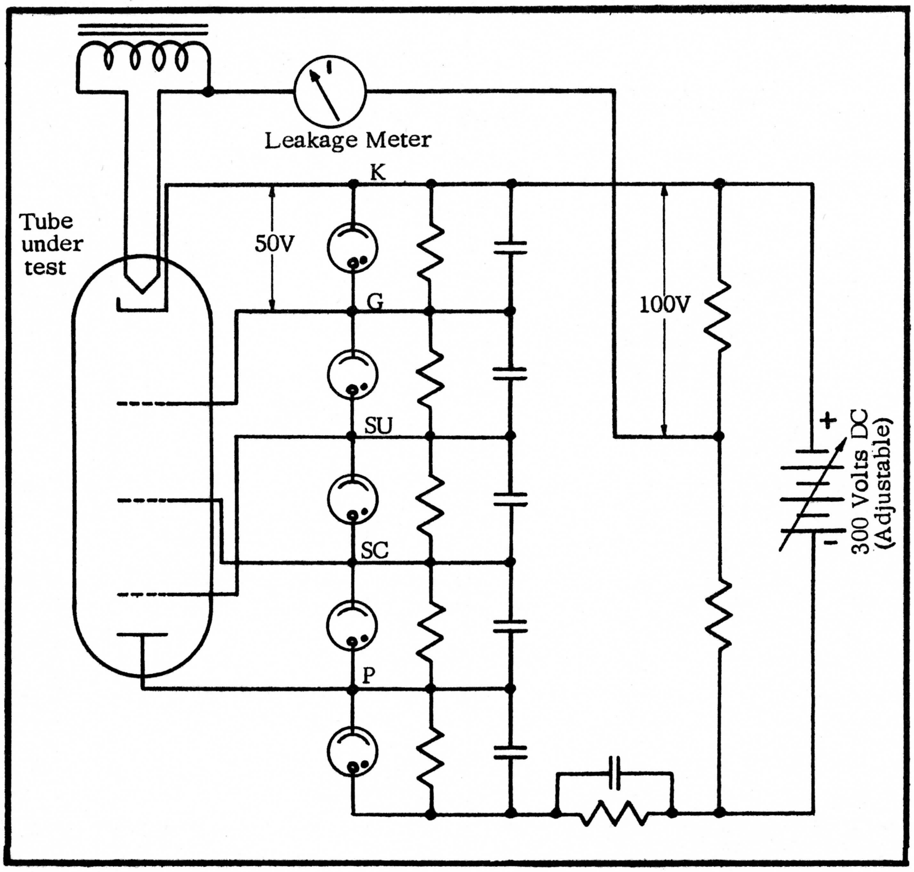



Figure 10 - Shorts and Cathode-to-Filament Leakage Test Circuit

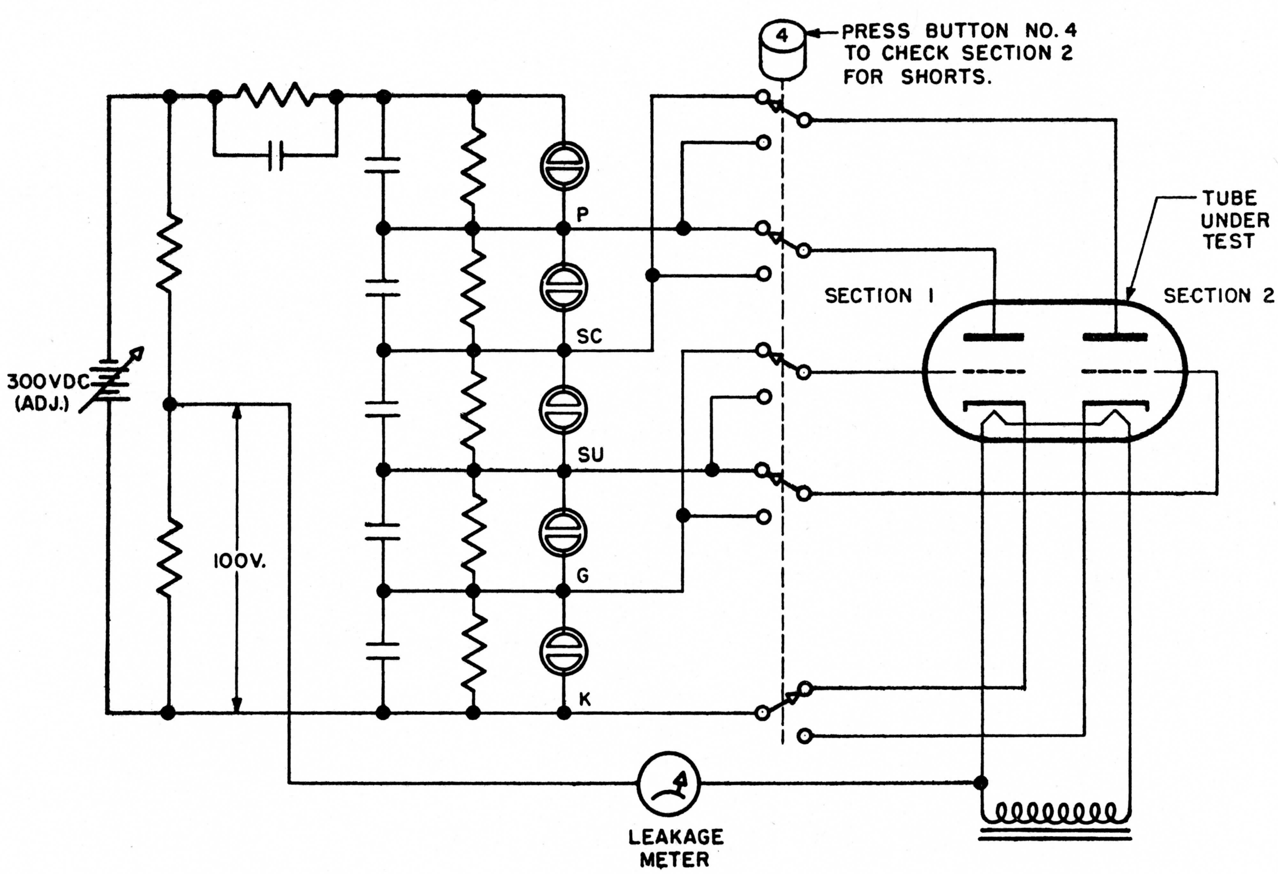



Figure 11 - Shorts and Cathode-to-Filament Leakage Test Circuit
(Multi-Section Tube)

5.11 The second rectifier test is for half-wave tubes in which the load resistance is adjusted in series with the milliammeter without the filter capacitor. The circuit for this test is shown in figure 8.

5.12 High voltage type rectifiers are tested on a circuit similar to that shown. High voltage ac is applied from the plate to the cathode in series with a load resistance and its filter capacitor and then through the dc milliammeter. A low voltage across the tube would reveal its emission characteristics but by using the load capacitor it is possible to develop approximately 1200 volts peak inverse which will show arcing conditions.

5.13 A high voltage diode may be checked for emission by the circuit shown in figure 8. The regulated power supply is connected directly across the tube and the current is metered through the tube. The reject value for this type of tube is fairly low and since the reject point is midscale on the meter most tubes will read near full scale.

5.14 Another type of emission circuit as shown in figure 8 is mainly for use in testing high perveance detector diodes. Ten volts dc is applied across the tube with the milliammeter in series. This type of tube is rated for about 60 MA and is rejected at about 25% of this figure. Low perveance diodes are tested the same way except it is necessary to use a higher impedance 10V supply. Low perveance tubes are rated about 2 MA with a reject point of about 0.3 MA.

5.15 Voltage regulator tubes are checked for continuity, leakage, voltage drop at low current and voltage drop at high current. The regulator tubes are tested by using four cards, one of which is an instruction card that is not inserted into the tester. The number 2 card measures leakage as shown in figure 9.

The tube jumpers are connected together and the voltage is applied across the tube in series with the meter. The reject point for these tubes is 10% of full scale. Card 3 is for measuring the voltage drop across the tube at low current while card 4 measures the drop at high current. The difference between the meter readings using these two cards is the regulating ability of the tube. The nearer to zero the difference the better the regulation. The number 1 card has test information to guide the operator in judging test results. Typical VR test circuits are shown in figure 9. The shorts test lamps are used to check jumper continuity. The left lamp will glow on cards 3 and 4 indicating a plate to cathode short. Should a tube have discontinuity no reading will be obtained on the tester meter when button 2 is pressed. Normally a good tube will read half scale on the meter.

5.16 Short Test. When a tube is inserted into the set for test, it is immediately subjected to a gradient type of DC voltage as illustrated in figures 10 and 11, which show the short test circuits for typical single and multi-sections. This voltage gradient is adjusted so that all five neon lamps are extinguished unless a resistive path exists across them. The voltage gradient appears across a series of relaxation oscillator circuits, composed of a capacitor and resistor connected to each lamp and tube element. The short resistance determines the charging rate of the capacitor. The capacitor charges to the lamp starting voltage then discharges through the lamp. The cycle then repeats. The circuit is thus set up so that the lamps will flash intermittently for a high resistance and glow steadily for a low resistance short. The DC voltage is polarized in such a way that if the tube exhibits grid emission the lamps will also flash. The sensitivity of the shorts test circuit from grid to cathode is 1 megohm indication and 2 megohms no indication. The sensitivity of the short test for various interelement shorts is shown in figure 12. A separate pushbutton in the auxiliary compartment is used to check critical grid-to-cathode shorts at a sensitivity of 10 megohms indication and 20 megohms no indication. If the neon short test lamps indicate that an interelement short exists, the chart in figure 12 should be used as an aid in identifying the shorted elements. Certain diodes, due to a shield connection in the test circuit, may indicate a short from grid or suppressor to the other tube elements. Damper diodes will show a plate-to-cathode short as a screen-to-cathode short due to the test circuit arrangement.

5.17 Leakage Test. This test is made by placing a microammeter in series with the heater and cathode, see figure 10. A system of shunts is available so that the reject point can be set up individually for the various types of tubes. The tester meter scale has definite reject point but actual current may be as low as 10 microamperes or as high as 150 microamperes depending on the type of tube. By using this system nearly any handbook condition can be duplicated. The amount of leakage tolerable is of course dependent on the application. As an example, a tube used in a cathode follower circuit with high cathode resistance may have to be rejected with as little as 10 microamperes of cathode to filament leakage. On the other hand a direct cathode to filament short in a tube used in a grounded cathode circuit may be insufficient cause for rejection.

5.18 Gas Test. Button 3 is used to test the tube for grid current due to gas. Pressing button 3 also actuates the button 2 through an interlock which operates the tube under normal bias and plate current conditions. If gas ions are present in the vacuum they will migrate to the negative grid and cause a current to flow which is read on the number 3 scale of the meter. The allowable grid current, due to gas, ranges from .5 to 3 microamps depending on the tube type. Of course, tubes having no grids cannot be tested for gas in this manner. In all of the tube tests a zero bias grid voltage is avoided because it would cause the meter to deflect to the left or opposite to that of gas current due to contact potential.

If the meter deflection is beyond the green sector of the meter under #3 test, the amplifier tube has a grid current in excess of 3 microamperes and it is definitely of no useful service. This reject point is based upon manufacturers' specifications for a large number of tubes. However, in circuits where there is a high grid impedance present even a 1/2 microampere grid current is harmful, therefore any up scale deflection under #3 test should be regarded with question for a given tube.

| PENTODE SHORT OR LEAKAGE PATH | NEON LAMPS P | SC | SU | G | K | FULL WAVE RECTIFIER OR DUAL DIODE AND DUAL TRIODE SHORT OR LEAKAGE PATH * | MAXIMUM SENSITIVITY REGION (MEGOHMS) |
|---|---|---|---|---|---|---|---|
| CATH - GRID | X | X | X | X | | CATH - GRID - SECT. 1 | 1-2 |
| CATH - SUPR. | X | X | X | | | CATH, SECT. 1 - GRID, SECT. 2 | 5-10 |
| CATH - SCRN. | X | X | | | | CATH, SECT. 1 - PLT., SECT. 2 | 15-30 |
| CATH - PLT. | X | | | | | CATH - PLT., SECT. 1 | 30-60 |
| GRID - SUPR. | X | X | X | | X | GRID, SECT. 1 - GRID, SECT. 2 | 1-2 |
| GRID - SCRN. | X | X | | | X | GRID, SECT. 1 - PLT. SECT. 2 | 5-10 |
| GRID - PLT. | X | | | | X | GRID - PLT., SECT. 1 | 15-30 |
| SUPR - SCRN. | X | X | | X | X | GRID - PLT., SECT. 2 | 1-2 |
| SUPR - PLT. | X | | | X | X | PLT., SECT. 1 - GRID, SECT. 2 | 5-10 |
| SCRN - PLT. | X | | X | X | X | PLT., SECT. 1 - PLT., SECT. 2 | 1-2 |

*CHART SHOWS INDICATIONS WITH BUTTON NO. 4 NOT PRESSED. WHEN BUTTON NO. 4 IS PRESSED, SECTION 1 BECOMES SECTION 2 AND SECTION 2 BECOMES SECTION 1. (SEE FIG. 11)

THE (X) MARK INDICATES A GLOWING LAMP.

Figure 12 - Interelement Shorts Identification

B. Circuit Description

5.19 For convenience the schematic circuit is divided into 4 parts. The power supply is shown on Sheet 1. Automatic circuit selection is on Sheet 2. Connections to the push buttons, shorts test and miscellaneous circuits are on Sheet 3 and wiring of the test sockets appears on Sheet 4.

5.20 Operating the "ON" switch causes the slave relay (K101) to lock in, connecting the line to the power supply. The power supply (Sheet 1) is fused with a pair of two ampere slo-blo fuses located on the top of the panel near the pilot lamp. Two reed relays are included in the protective system; one for overloads on the main regulated B+ supply and one for excessive meter deflection. The meter has contacts at both the high and low ends of its scale. A heavy overload in either direction will close one set of the contacts actuating reed relay (K104) and cause the slave relay (K101) to disconnect the line.

5.21 The filament transformer is protected by a 100 watt electric light bulb. This lamp functions as a non-linear resistance network to assure that the filament drain never exceeds 20 watts. When a direct short circuit is applied to the secondary of this transformer the lamp absorbs the overload.

5.22 The filament transformer supplies ac voltages for tubes under test. These voltages are reduced 10% through a switch in the primary winding for cathode activity tests.

5.23 The filament transformer primary also has a selector switch that is used to compensate for variations in line voltage over a range of 97.5 to 125 volts. This switch may be used for critical tests or for tubes having heavy filament drains. However, for normal tests it is left at the 115 volt point.

5.24 The tester has three operational B+ supplies which are: the main B+, auxiliary B+ and unregulated B+. The main B+ is used as the plate the screen supply for the tube under test. Referring to the power supply schematic, the 250V taps of the power transformer supply the 5U4 rectifier which is in turn connected to the plate of the 6CD6 series regulator tube. The pentode section of the 6AW8 is an amplifier for the feedback loop which controls the grid of the 6CD6 by sensing the output voltage called for or by sensing a need for regulation because of voltage change. The triode section of the 6AW8 is a voltage reference tube to establish a constant potential at the cathode of the pentode section. The 6C4 is a low impedance control tube for the screen of the series regulator and is driven from the plate circuit of the amplifier tube. Both grids of the series regulator are being driven but the control is directly to the screen by a voltage from the 6X4 through the 6C4 control tube. The only filtering is through the screen supply from the 6X4. The output voltage from this supply is controlled by the group of resistors in series which is shown on Schematic Sheet 2. By closing various switch combinations a voltage from 10 volts to 260 volts in 10 volt steps may be selected. The current drain of the voltage selection network is constant at 1 MA.

5.25 The auxiliary B+ supply is used primarily in cold cathode tube tests but may be used for other special data requirements. It is supplied by the 6X4 rectifier with the 6CL6 being used as the series regulator. The pentode section of the 6AU8 is the loop amplifier for the feedback circuit. The circuit is manually controlled by the auxiliary B+ potentiometer. It is monitored by pressing a button and reading the tester meter. The voltage may be interpreted by multiplying the meter reading by three (the monitoring meter reads 300 volts full scale). The supply is fused and does not operate through the protective relay circuit. The supply is variable from 30 volts to 300 volts at currents up to 30 MA.

5.26 The unregulated B+ is obtained from the cathode of the 5U4 through a simple filter. It provides approximately 350 volts which varies with line and load. It is used in tests where the voltage is immaterial but a high current is desired. An example of this would be in a high emission "knee" test of a pulse power pentode.

5.26 The unregulated B+ is obtained from the cathode of the 5U4GB through a simple filter. It provides approximately 350 volts which varies with line and load. It is used in tests where the voltage is immaterial but a high current is desired. An example of this would be in a high emission "knee" test of a pulse power pentode.

5.27 The tester has a low current regulated supply of approximately plus 150 volts which has four uses as follows: a positive reference grid supply, a voltage for operating the reed relay, K104, for the meter contacts, a part of the supply for the shorts test and part of the heater to cathode leakage test. It is derived from the 6X4 through the 6AU8 triode connected as a shunt regulator. A feedback system of neon lamps establishes the +150 volts. The positive reference is taken off a resistive network from 0 volts to +150 volts. This supply can be used as a reference voltage for the grid of a tube under test. It allows the use of larger self bias resistance while the equivalent tube is still negative.

5.28 The minus 150 volt supply is stabilized and is the basic reference voltage for all other regulator supplies. It forms the negative potential for the shorts test and heater to cathode leakage test circuits and is used as the bias supply. It also supplies the voltage for the hold coil on reedrelay, K104, in the protective circuit. It is derived from 275 volts each side of the center tap and through rectiviers CR101 and CR102. The OA2WA shunt regulator controls the minus supply and is the voltage reference for all regulated supplies.

5.29 The fixed bias supply, for tubes under test, is obtained directly across the OA2WA tube. It has a range of 0.1 volt to 100V in approximately 0. 1 volt steps by using a decade resistor system which is shown on Schematic Sheet 2.

5.30 The bias off supply is similar to the fixed bias supply. It is used to hold off a section of a tube while another section is being tested. An example of its use would be for testing a dual pentode with common screen and common cathode.

5.31 The power supply furnishes a grid signal of 0. 222 volts from the 10 volt winding of the transformer and an ac bridge type regulating circuit:

5.32 Other voltages from the power supply are:

(a) 250 volts ac used mainly for rectifier tests
(b) 10 volts for driving the transconductance bridge
(c) Filament supplies for tubes within the power supply

5.33 The secondary of the transformer which supplies voltages to the filaments of tubes under test is shown on Schematic Sheet 2. These voltages may be varied from 0.1 volt to 119.9 volts in 0.1 volt steps. Sheet 2 also shows a full wave bridge rectifier which supplies up to 1.0 ampere of dc for filamentary type tubes. This DC filament supply is fused and does not depend on the protective relay circuit for protection.

5.34 Referring to Schematic Sheet #2 it may be seen that it is largely composed of single pole single throw switches and resistors. These switches are labelled according to their positions in the card switch. By closing various combinations of these switches, the program card automatically selects the circuits to be used on the tube under test.

5.35 The group of switches and resistors (R215, R229 and R231) along the bottom of the sheet form a decade resistance network. This network is used for applying the proper fixed bias to the tube under test up to 100 volts in 0.1 volt steps by closing various switches to short out unwanted resistors. This decade system has many uses other than negative grid bias. By referring to the circuit theory section it may be seen that it is used as cathode resistance in self bias tests; it is applied to both control grids in heptodes and is often used as voltage dropping resistance in other tests.

5.36 Referring again to schematic sheet 2 there is another group of switches and resistors

| VOLTS | CLOSE SWITCH | VOLTS | CLOSE SWITCH |
|---|---|---|---|
| 10 | D-17, L-3, L-4 | 140 | B-17, L-4 |
| 20 | D-17, E-17, L-4 | 150 | B-17, E-17 |
| 30 | D-17, L-4 | 160 | B-17 |
| 40 | D-17, E-17 | 170 | L-2, L-3, L-4 |
| 50 | D-17 | 180 | L-2, E-17, L-4 |
| 60 | C-17, E-17, L-3, L-4 | 190 | L-2, L-4 |
| 70 | C-17, L-3, L-4 | 200 | L-2, E-17 |
| 80 | C-17, E-17, L-4 | 210 | L-2 |
| 90 | C-17, L-4 | 220 | L-3, L-4 |
| 100 | C-17, E-17 | 230 | E-17, L-4 |
| 110 | C-17 | 240 | L-4 |
| 120 | B-17, L-3, L-4 | 250 | E-17 |
| 130 | B-17, E-17, L-4 | 260 | None |

5.37 The group of switches and resistors (R203 to R205) is used as shunts to the meter for establishing sensitivity of the leakage test.

5.38 The group of switches and resistors in the center of schematic sheet 2 at the top, is used as shunts and multipliers for the meter when used in the quality test. These shunts and multipliers make it possible to provide broad ranges of sensitivities as discussed in the section on circuit theory.

5.39 The group of components in the center of schematic sheet 2 forms the Gm bridge circuit. For purposes of analyzing this circuit consider the meter and its shunts connected across condensers C401 and C402 and a 10 volt transformer winding connected across C403. The transformer winding acts as a bias source to alternately turn on diodes CR401 and CR403 while turning off diodes CR402 and CR404 and vice versa. By this action all the DC current that enters the bottom end of the bridge is chopped into alternating current, sent through the meter and its shunts, and put back together again into a DC current as it flows out of the top of the bridge. The meter, which is a direct current average reading device, will respond to the difference in the magnitude of the two alternating current pulses. By modulating the grid of the tube under test with an AC signal of the same phase relationship as the 10 volt bias winding in the bridge, these two current pulses will be of different magnitude and the meter can be calibrated directly in micromhos inasmuch as it is responding to a minute change in plate current with minute change in grid voltage which is by definition, transconductance. The resistor network, consisting of R402 to R406, is of a high impedance nature and is used to balance out the back resistance characteristics of the diodes. Potentiometer R405 is then called Gm balance low current. Potentiometer R401 is of very low value and is in series with the diodes. This potentiometer is called Gm balance high current and is used to balance the bridge for the forward characteristic of the diodes at a high current. This circuit is separately fused in order to prevent damage to the bridge under certain short circuit conditions that cannot be sensed by the relay protection circuit.

5.40 The rest of the contact groups appearing on sheet 2 are used to establish the test configuration and to control miscellaneous other circuits.

5.41 Sheet 3 of the schematic contains a group of card switch contacts which provide connections to the pins of the tube under test. The short, leakage and gas test circuits are shown on this figure but are completely described in 5.16, 5.17 and 5.18. The remainder of sheet 3 consists of the push button and meter circuits. It should be noted that when button 3 (GAS) is pressed it also actuates button 2 (QUALITY). This maintains normal operating conditions on the tube but switches the meter to the grid circuit.

C. Amplifier Tube Test Circuit Programming

5.42 With the help of a tube manual as published by tube manufacturers the following instructions will enable establishment of a desired test circuit for an amplifier tube. Wiring diagrams, Sheet 2 of 4, Sheet 3 of 4 and Sheet 4 of 4 at the back of this book should be studied before any circuits are begun.

5.43 Test Socket Pin Connections. The pins of the various test sockets are wired in parallel according to the standard EIA designation. See Wiring Diagram Sheet 4 of 4. It will be noticed that the top cap connector is identified as pin 10. The following table may be used to connect the supply voltages to the desired tube socket pins. Note also that the letter "I" is omitted.

| Socket Pin Number | Cardmatic Switch Column Letter |
|---|---|
| 1 | A |
| 2 | B |
| 3 | C |
| 4 | D |
| 5 | E |
| 6 | F |
| 7 | G |
| 8 | H |
| 9 | J |
| CAP | K |

5.44 The Cardmatic switch rows 1 and 2 are the filament (or heater) supply lines. Row 1 is the filament plus (+) supply and Row 2 is the filament minus (-) supply. One letter of each of these rows must be chosen to connect the desired pins to the filament voltage. If a heater is desired to be connected in parallel then two letters of one of these rows must be used with one of the other row. Never close the same switch letters on Rows 1 and 2 as the filament voltage source will be shorted; that is, never close A-1, A-2; B-1, B-2; C-1, C-2, etc. Some common heater pins are: 2 and 7 - close B-1 and G-2; 3 and 4 - close C-1 and D-2, 4 and 5 - close D-1 and E-2. An example of a 12AU7 heater in parallel would be: close D-1, E-1 and J-2 or J-1, D-2 and E-2.

5.45 The cardmatic switch row 3 is the control grid line. A negative or a positive bias voltage may be applied to this line with or without the 0.222 volt signal. An example of connecting test socket pin 4 to this line would be to close D-3.

5.46 The Cardmatic switch row 4 is the cathode line. The line may be connected to the "0" volts floating ground; it may be by-passed with a 1000 microfarad capacitor to the "0" volts line; it may be connected to the suppressor line; it may be connected to the decade resistors which act as a load, a grid bias divider, or a self bias resistor; and it may be by-passed by a 4 microfarad capacitor to the opposite end of the decade resistors. An example of connecting test socket pin 8 to this line would be to close H-4.

5.47 The Cardmatic switch row 5 is the screen line. This line may be connected to the regulated B+ source, to the "bottom" of the Gm bridge, to the "top" of the Gm bridge, to one end of a 500 volt AC center-tapped transformer winding or to an auxiliary B+ (0 to 300 VDC knob controlled) supply. An example of connecting test socket pin 6 to this line would be to close F-5.

5.48 The Cardmatic switch row 6 is the suppressor line and four possible connections may provide different voltages to it. By closing L-16 the suppressor is tied directly to the cathode, by closing K-16 the suppressor is returned to the "0" volts or floating ground reference point, by closing J-16 the suppressor is connected to a high negative bias (approximately 50 VDC when C-16 is also closed) which is useful in twin tetrode tests, and by closing H-16 the same bias

maybe applied to the suppressor grid as the control grid except without the signal. An example of connecting test socket pin 7 to this line would be to close G-6.

5.49 The Cardmatic switch row 7 is the plate line. Switch J-17 places the negative terminal of the meter to this line for DC current measurements, switch K-17 connects the "top" of the Gm bridge to this line and switch L-17 connects the remaining end (see para. 5.47) of the 500 volt AC center-tapped transformer winding for rectifier tests.

5.50 The Cardmatic switch row 8 is used for special circuits where two tube pins may be connected without a short test voltage or any other voltage directly applied. This line may be returned to the "0" volts reference point without the transient effect of button No. 2. Also, in twin diode and triode testing, this line may function as the cathode line when button No. 4 interchanges rows 4 and 8.

5.51 Twin Tube Section Circuitry. For a twin triode such as a 12AU7 the first section (pins 6, 7, 8) should be treated as a single triode where row 7 is to be used for the plate, row 3 is to be used for the grid and row 4 is to be used for the cathode. Since Button No. 4 interchanges plate and screen (row 7 and row 5), grid and suppressor (row 3 and row 6) and cathode and row 8 (row 4 and row 8), the second triode elements must be connected as follows: the plate is connected to row 5, the grid is connected to row 6 and the cathode is connected to row 8. See Figure 11. For this dual testing the lamp next to Button No. 4 should be lighted. Close J-8. To establish the function of row 8 as a cathode close K-8. If switch J-15 is used the regulated B+ voltage will be on the second section plate. Therefore consideration must be given to the suppressor supply (second section grid). When switch C-16 and the associated circuitry for the negative grid bias is used (see paragraph 5.57) switch J-16 will provide about 50 VDC negative on the suppressor row 6. This voltage may be used for cutting off plate current in the untested section in case the respective cathode is returned to the "zero volts" or floating ground point. One such case may be when a 6J6, which has a common cathode, is desired to be tested one section independent of the other. When the same cathode pin is to be used on the second section test close the switch in row 8 that is in the same column as that in row 4. In the case of the 6J6 basing close G-4 and G-8.

If it is desired to bias off the untested section of a twin triode such as the 6J6 while the section under test is in a self-bias circuit, then switch C-16 must be closed to be assured of 50 volts and not 150 volts negative through switch J-16 to the suppressor row 6. Switch C-15 will provide the "ground" end connection of the self-bias resistance through switch A-16.

5.52 Heater Voltages. The AC heater or filament voltages are obtained from the sum of three decade steps: tens of volts, units of volts and tenths of volts. The voltage chosen is applied to row 1 and row 2 to pins of a tube when switches A-12 and B-15 are closed. One switch of each of the three decades must be closed for the desired voltage.

| Volts | Switch | Volts | Switch | Volts | Switch |
|---|---|---|---|---|---|
| 0: | A-9 | 0: | A-10 | 0.0: | A-11 |
| 10: | B-9 | 1: | B-10 | 0.1: | B-11 |
| 20: | C-9 | 2: | C-10 | 0.2: | C-11 |
| 30: | D-9 | 3: | D-10 | 0.3: | D-11 |
| 40: | E-9 | 4: | E-10 | 0.4: | E-11 |
| 50: | F-9 | 5: | F-10 | 0.5: | F-11 |
| 60: | G-9 | 6: | G-10 | 0.6: | G-11 |
| 70: | H-9 | 7: | H-10 | 0.7: | H-11 |
| 80: | J-9 | 8: | J-10 | 0.8: | J-11 |
| 90: | K-9 | 9: | K-10 | 0.9: | K-11 |
| 100: | L-9 | | | | |
| 110: | L-10 | | | | |

For DC filament voltages A-12 and B-15 must be open, with K-1 and K-2 closed. Since the

voltage drop across the silicon full-wave bridge rectifier is proportional to the load current and since this drop is an appreciable percentage of the desired output voltage it becomes simpler to meter the DC voltage across the filament pins of a tube while adjusting the AC winding taps. The silicon diodes are rated at 0. 5 ampere and the circuit is fused for 1 ampere. To properly tie in the filament to the cathode line the same column lettered switch in row 4 should be closed as is closed in row 2. This will short the 50 ohms that is used at other times in reaching the electrical center of AC heated tubes. This short will also appear as a heater-cathode short on the meter scale and therefore switch G-17 must be closed to eliminate the DC heater-cathode leakage test voltage.

5. 53 Heater-Cathode Leakage Meter Sensitivities. Whenever G-17 is open, Cardmatic switch rows 1 and 2 are used for a heater and row 4 is used for a cathode, a heater-cathode leakage test is being applied which consists of 100 VDC in series with a microammeter.

At rejection (10% of full scale) the following meter values are obtained:

| | |
|---|---|
| A-14, B-14, C-14 each open | 10 microamperes |
| A-14 only closed | 20 microamperes |
| B-14 only closed | 50 microamperes |
| A-14, B-14 each closed | 70 microamperes |
| C-14 only closed | 100 microamperes |
| B-14, C-14 each closed | 150 microamperes |

5. 54 Regulated B+ Supply. Refer to paragraph 5. 36 to set the regulated B+ supply from 10 volts to 260 volts at any 10 volt level. The minimum allowable output current of this supply depends upon three conditions: (1) maximum plate dissipation of the passing tube, (2) characteristics of the passing tube under low line voltage and (3) maximum available voltage in the tester. Refer to the following tabulation for maximum allowable currents:

| Regulated B+ Supply Volts | Maximum Current (MA) | Regulated B+ Supply Volts | Maximum Current (MA) |
|---|---|---|---|
| 10 | 69 | 140 | 140 |
| 20 | 72 | 150 | 140 |
| 30 | 75 | 160 | 129 |
| 40 | 76 | 170 | 120 |
| 50 | 80 | 180 | 110 |
| 60 | 82 | 190 | 102 |
| 70 | 86 | 200 | 94 |
| 80 | 90 | 210 | 85 |
| 90 | 95 | 220 | 77 |
| 100 | 100 | 230 | 68 |
| 110 | 110 | 240 | 60 |
| 120 | 119 | 250 | 50 |
| 130 | 129 | 260 | 42 |

These regulated B+ voltages are available to be used on the screen (row 5) and/or plate (row 7) for plate current or mutual conductance tests. To connect the regulated B+ to the screen line (row 5) close J-15. To connect the B+ to one end of the Gm bridge close J-15 and H-15 and to complete the Gm bridge circuit to the plate (row 7) close K-17, A-13, B-13 and H-13.

5. 55 Micromhos Full Scale Meter Sensitivities. Switches L-7, L-12, C-12, D-12, E-12, F-12, G-12, H-12, J-12, and K-12 determine the full scale micromho value of the meter. Since there are over 500 ranges of micromhos only some of the more useful values are tabulated in the following:

| Full Scale Micromhos | Close | Full Scale Micromhos | Close |
|---|---|---|---|
| 500 | L-12 | 4500 | F, H, L-12 |
| 600 | C, L-12 | 5000 | C, E, F, H, L-12 |
| 700 | D, L-12 | 6000 | C, D, E, G, H, L-12 |
| 800 | C, D, L-12 | 7000 | C, J, L-12 |
| 900 | E, L-12 | 8000 | C, D, F, J, L-12 |
| 1000 | C, E, L-12 | 9000 | C, E, G, J, L-12 |
| 1200 | C, D, E, L-12 | 10,000 | C, D, E, F, G, J, L-12 |
| 1500 | D, F, L-12 | 12,000 | C, D, G, H, J, L-12 |
| 1800 | C, E, F, L-12 | 15,000 | C, G, L, L-12 |
| 2000 | C, D, E, F, L-12 | 20,000 | C, D, J, K, L-12 |
| 2500 | E, G, L-12 | 25,000 | C, E, G, H, J, K, L-12 |
| 3000 | C, F, G, L-12 | 40,000 | C, D, E, F, J, L-7 |
| 3500 | D, E, F, G, L-12 | 60,000 | C, D, E, G, H, J, L-7 |
| 4000 | C, D, H, L-12 | 100,000 | C, D, E, J, K, L-7 |

The full scale value in micromhos may also be determined from the following when switch L-12 is closed:

Gm = 500 plus 100 times the choice number and
Choice No. = Gm less 500 divided by 100.

A choice number is an arbitrary assignment of a number to a meter shunt resistance so that a convenient mathematical relationship exists for the series of combinations. When a desired meter shunt resistance is one of the eight resistors the choice number is identified as "primary". A "secondary" choice number is then one that is made up of primary choice numbers.

The primary choice numbers are related to the meter shunt resistors according to the binary system:

| Primary Choice No. | Meter Shunt Resistor | Switch Closed (with L-12) |
|---|---|---|
| 1 | A (1280Ω) | C-12 |
| 2 | B (640Ω) | D-12 |
| 4 | C (320Ω) | E-12 |
| 8 | D (160Ω) | F-12 |
| 16 | E (80Ω) | G-12 |
| 32 | F (40Ω) | H-12 |
| 64 | G (20Ω) | J -12 |
| 128 | H (10Ω) | K-12 |

Choice No. zero is obtained when no meter shunt resistor is used. The primary choice numbers may be added to form secondary choice numbers. Secondary Choice No. 31, for example, consists of the summation of primary choice Nos. 1, 2, 4, 8 and 16. Secondary choice numbers consist of combinations of only single primary choice numbers. A primary choice number cannot be used twice, as inspection of switching will reveal. To determine the primary choice numbers for a given secondary choice number begin with the highest possible primary choice number and subtract, repeating this procedure until all the primary choice numbers are found. For example, the primary choice numbers for choice number 51 are desired. Since 51 is between 32 and 64, subtract 32 (use Resistor "F", switch H-12) which leaves 19. This number is between 16 and 32: subtract 16 (use resistor "E", switch G-12) which leaves 3. This number is between 2 and 4: subtract 2 (use resistor "B", switch D-12) which leaves 1 (use resistor "A", switch C-12). Choice number 51 is then made up of 1, 2, 16 and 32, and corresponds with the use of meter shunts "A" - 1280Ω, "B" - 640Ω, "E" - 80Ω and "F" - 40Ω. The full scale value in micromhos for choice number 51 is then:

Gm = 500 + 100 x 51 = 500 + 5100 = 5600

Reversing the order, for a full scale of 5600:

Choice No. = (5600 - 500)   100 = 5100   100 = 51

Observing this series it will be noted that:

1. Full scale Gm values begin at 500.
2. Full scale Gm values progress in 100 micromho steps.
3. There are 256 full scale values of Gm available.
4. The maximum full scale Gm value is 26, 000.

An alternate system for determining the meter shunt resistors for desired full scale values of micromhos may be employed.

With no meter shunt and with L-12 closed the full scale value is 500.

Each meter shunt resistor then adds the following to the initial 500 micromhos.

| Added Full Scale Micromhos | Meter Shunt Resistor | Switch Closed with L-12 |
|---|---|---|
| 100 | A (1280Ω) | C-12 |
| 200 | B (640Ω) | D-12 |
| 400 | C (320Ω) | E-12 |
| 800 | D (160Ω) | F-12 |
| 1600 | E (80Ω) | G-12 |
| 3200 | F (40Ω) | H-12 |
| 6400 | G (20Ω) | J -12 |
| 12, 800 | H (10Ω) | K-12 |

The meter shunt resistors can be determined by subtracting 500 from the desired full scale value and from this remainder by subtracting the highest possible added full scale values.

For example, 9300 micromhos full scale is desired. Subtract 500 which leaves 8800. From the table, 6400 (Resistor "G" - 20Ω) is subtracted next which leaves 2400. Subtract 1600 (Resistor "E" - 80Ω) which leaves 800 (Resistor "D" - 160Ω). Therefore, resistors D, E, G will provide a 9300 micromho full scale range.

5.56 Extended Ranges of Full Scale Meter Micromhos. With switch L-12 closed and with all the meter shunt resistors used, the maximum full scale value is 26,000 micromhos. By leaving L-12 open and by closing L-7 the basic metering is extended and by repeating the same shunts across the extended meter a new set of micromho ranges is obtained. Although this set of ranges also begins at 500 micromhos its usefulness begins at 26, 000 micromhos and it is recommended that full scale values from 26, 000 to 128, 000 micromhos only be used. For 500 to 26,000 micromhos the extended Gm ranges may inherently introduce plate circuit resistances which will result in readings deviating appreciably from the theoretical.

With switch L-7 closed, use the "Choice No." system with the same meter shunt identification with the following:

Gm = 500 (1 + Choice No. ) and

Choice No. = Gm ÷ 500 less 1

Examples:

Choice No. 84 represents shunt resistors C, E and G (switches E-12, G-12 and J-12).

Full Scale Gm = 500 (1 + 84) = 500 x 85 = 42, 500.

Desired: 80, 000 micromhos full scale.

Choice No. = 80, 000 ÷ 500 less 1 = 160 - 1 = 159.

Choice No. 159 represents shunt resistors A, B, C, D, E and H or switches C, D, E, F, G, K-12 closed with L-7 closed and L-12 open.

5. 57 Negative Grid Bias Voltages. The grid bias voltages are obtained according to the formula: $E_c = 150R \div (R + 15,000)$.

The following switches must be closed to apply a negative voltage from cathode (row 4) to grid (row 3):

| | |
|---|---|
| H-14 | K-13 (without 0. 222 V signal) |
| L-14 | L-13 (with 0. 222 V signal) |
| A-16 | Never close both K-13 and L-13. |
| C-16 | |

Select resistance "R" according to the above formula by leaving one or more of the following switches open:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10Ω: | D-13 | 100Ω: | E-13 | 1000Ω: | F-13 | 10, 000Ω: | G-13 |
| 20Ω: | D-14 | 200Ω: | E-14 | 2000Ω: | F-14 | 20, 000Ω: | G-14 |
| 30Ω: | D-15 | 300Ω: | E-15 | 3000Ω: | F-15 | 30, 000Ω: | G-15 |
| 40Ω: | D-16 | 400Ω: | E-16 | 4000Ω: | F-16 | | |

5. 58 Self-bias Tests. If a triode or pentode is desired to be tested under self-bias the grid-cathode circuit must be arranged according to the following:

Close H-14, K-14, A-16, C-15, K-13 (L-13 if the signal is desired instead of K-13) and all except the resistance desired of the following:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10Ω: | D-13 | 100Ω: | E-13 | 1000Ω: | F-13 | 10, 000Ω: | G-13 |
| 20Ω: | D-14 | 200Ω: | E-14 | 2000Ω: | F-14 | 20, 000Ω: | G-14 |
| 30Ω: | D-15 | 300Ω: | E-15 | 3000Ω: | F-15 | 30, 000Ω: | G-15 |
| 40Ω: | D-16 | 400Ω: | E-16 | 4000Ω: | F-16 | | |

Note that a resistance may be made up of several combinations of these series resistors. A resistance of 50 ohms may consist of 10 and 40 or 20 and 30. A resistance of 1000 ohms may consist of 1000 ohms; 100, 200, 300, 400; or 10, 20, 30, 40, 200, 300 and 400. These decade resistors are within 1% of their indicated value. Also, 200 milliamperes may be passed through any resistor from 10 ohms up to and including the 1000 ohm resistor which is across F-13. The remaining individual resistors should never have in excess of 200 volts across them.

5. 59 Plate Circuit Arrangement for Plate Current Measurements. In the event that a plate current test is desired using the regulated B+ source close J-15, K-15, A-13, C-13, J-17 and the suitable meter shunts C, D, E, F, G, H, J, K, L-12 and/or L-7. For pentodes the screen and plate voltage are the same for this circuit.

5. 60 Meter Current Ranges. Since 50 on the 0-100 scale is the rejection point for most tubes, a convenient mathematical relationship was made to exist at half-scale for the current ranges. This tester has three sets of overlapping DC current ranges. With reference to the lettered resistors used for meter shunting in the "Choice Number" system for mutual conductance ranges the following formulas are useful in setting desired meter ranges.

With L-12 closed:

I (half scale) = 50 + (Choice No. x 10) microamperes.

Example: For Choice No. 200 (resistors D, G, H: switches F-12, J-12 and K-12 closed)

I (at 50) = 50 + 200 x 10 = 50 + 2000 = 2050 microamperes or 2. 05 milliamperes

This value of 2. 05 ma at 50 means 4. 1 milliampere full scale.

With L-12 open and L-7 closed:

I (half-scale) = 50 + (Choice No. x 50) microamperes.

Example: For Choice No. 192 (resistors G, H: switches J-12 and K-12 closed)

I (at 50) = 50 + (192 x 50) = 50 + 9600 = 9650 microamperes or 9. 65 milliamperes

This value of 9. 65 ma at 50 means 19. 30 milliamperes full scale.

With L-7 and L-12 open:

I (half scale) = 0. 05 + (Choice No. ) milliamperes

Example: For Choice No. 96 (resistors F, G: switches H-12 and J-12 closed)

I (at 50) = 0. 05 + 96 = 96. 05 milliamperes

This value of 96. 05 milliamperes means 192. 1 ma full scale.

With L-12 closed the maximum available full scale value is 5200 microamperes or 5. 2 milliamperes, with L-7 closed the maximum available full scale value is 25.6 milliamperes and with L-7 and L-12 open the maximum available full scale value is 510. 1 milliamperes.

Examples of useful ranges are as follows:

| Full Scale Microamperes | Close L-12 and: | Full Scale Microamperes | Close |
|---|---|---|---|
| 100 | L-12 alone | 1000 | C, E, F, H-12 |
| 200 | C, E-12 | 2000 | C, D, E, F, G, J-12 |
| 500 | E, G-12 | 5000 | C, E, G, H, J, K-12 |

| Full Scale Milliamperes | Close L-7 and: | Full Scale Milliamperes | Close L-7 and: |
|---|---|---|---|
| 6 | C, D, F, G, H-12 | 12 | C, D, E, G, H, J-12 |
| 8 | C, D, E, F, J-12 | 15 | C, E, G, K-12 |
| 10 | C, D, H, J-12 | 20 | C, D, E, J, K-12 |

| Full Scale Milliamperes | (L-7 and L-12 Open) Close | Full Scale Milliamperes | (L-7 and L-12 Open) Close |
|---|---|---|---|
| 30 | C, D, E, F-12 | 200 | E, H, J-12 |
| 50 | C, F, G-12 | 300 | D, E, G, K-12 |
| 100 | D, G, H-12 | 500 | D, F, G, H, J, K-12 |

5.61 Miscellaneous Switches. For filamentary tubes switch L-11 places a 100 ohm center-tapped resistor across the filament to reach the electrical center. One end of this resistor is permanently connected to row 2 or the filament minus (-) supply and the center-tap becomes connected to the cathode supply after the quality button (No. 2 button) is depressed. Do not close L-11 when the filament or heater voltage is greater than 12.6 volts.

Switch G-17 is closed for filamentary amplifier tubes to prevent a meter deflection for normal tubes on the heater-cathode leakage test.

For all filamentary tube types close switches A-12, B-14 and C-14. If these switches are open and a plate or screen to filament short is present the meter will deflect to the left with appreciable force although no damage will be done. Since this deflection is not intended to identify the short, the meter sensitivity may be reduced by using the three heater-cathode leakage parallel resistors across the meter.

D. Diode and Rectifier Tube Test Circuit Programming

5.62 The filaments and heaters of diodes and rectifiers should be treated the same as those for amplifier tubes. For filamentary types it will be sufficient to close L-11 only and it will not be necessary to close the switch in row 4 that corresponds to the switch closed in row 2. Also, it will not be necessary to close G-17 for diodes and rectifiers.

5.63 Heater - Cathode Leakage Consideration for Diodes and Rectifiers. For detector-type diodes wherein signals to be amplified are involved, a lower value of rejection may be set. A value of 20 microamperes is generally satisfactory. For power rectifiers a higher level of leakage is acceptable and 150 microamperes is suitable for most tubes such as the 6X4. Damper diodes used in horizontal deflection circuits for cathode ray tubes are made to withstand higher heater-cathode voltages than other types of rectifiers. Therefore a lower level of leakage is an inherent feature of this tube. Rejection at 10 microamperes is desired for damper diodes. For filamentary diodes or rectifiers use switches A-14, B-14, and C-14 for the reason stated in paragraph 5.61, Miscellaneous Switches.

5.64 Plate-Cathode Circuit Configurations.

a. The simplest of diode test circuits is one wherein the diode is treated as a triode without the grid-cathode circuit consideration. With L-14 closed and the rest of the plate circuit arranged per paragraph 5.58 a plate current test is readily provided. For DC currents up to 30 milliamperes the manually controlled Auxiliary B+ supply may be used by opening J-15 (and K-5) and by closing L-5. The 0-100 scale indication X3 will be the applied DC voltage when monitored by depressing the Aux. B+ button in the Auxiliary Control Compartment. If current limiting resistance is desired in the plate-cathode circuit open L-14, close H-14, A-16, C-15 and open the switches across the desired decade resistors described in paragraph 5.57. Because of the current delivering capability of the regulated DC supplies, the meter ranges available and the resistances attainable the described circuit is suitable for plate current tests on high voltage diodes and high and low perveance diodes.

b. Half-wave power rectifiers intended for use with a 117 VAC line may be tested in a circuit that subjects the tube to its rated inverse voltage at the same time

that it is delivering rated DC current. The plate of such a tube should be connected to the proper switch on row 7 (see paragraph 5.49) and switch L-17 should be closed. Switch L-17 provides 250 VAC (350 V peak) to be applied between the floating ground and the plate of the tube. The cathode to ground circuit is completed by the following switches: H-14, the desired decade resistors for a load, B-16, C-13, A-13, the desired meter range, and J-13. For a half-wave rectifier with a maximum 330 volt inverse rating do not close J-14. It is recommended that the meter sensitivity be set so that 63 on the 0-100 scale represents the value of rated current for the tube. Then, starting with the highest value for the load resistance, the decade resistance should be decreased until the meter reads 63. A reading of 63 for rectifiers will provide the acceptable 80% of average rejection factor for output current when rejection is to be regarded at 50.

c. Full-wave power rectifiers may be treated the same as half-wave power rectifiers except the second plate must be connected to the "screen" row 5 and switch L-15 must be closed. Switches L-15 and L-17 provide 500 VAC plate to plate with the center of this transformer winding connected to the floating ground. Close switch J-14 to place a 4 microfarad capacitor across the load resistance. The maximum current that may be passed through a rectifier tube is limited by the rating of the resistors that are used as a load in the tester. See paragraph 5. 57 for these ratings.

d. Damper diodes such as the 6AX4 may be tested in a half-wave circuit that subjects the tube to an inverse voltage of about 1200 volts. Connect the cathode pin to row 4 and close switches H-14, J-14, open the switches across the desired load resistances (decades), close B-16, C-13, A-13, the switches for the desired meter sensitivity, J-17 and L-17. The plate of the damper diode must be connected to the screen row 5 and L-15 must be closed. If the rated current is attempted to be drawn through this type of tube the load reflected to the primary of the transformer will cause a fuse to open. Therefore, it is recommended that 92 milliamperes maximum be drawn through any damper diode. The decade resistances will be near 5500 ohms for this condition.

6. MAINTENANCE

A. General

6.01 Most maintenance on this equipment can be accomplished with the aid of the Routine Calibration procedure, the Complete Calibration Procedure, the Trouble Shooting Procedure and the Voltage and Resistance Chart. All these procedures make use of test cards stored in the tester case cover.

B. Complete Calibration

6.02 Perform the Routine Calibration procedure as listed in section 3. Then proceed as follows:

6.03 Signal Adjustments:

a. Connect the tube tester to the power line thru a Variac set to 115 volts. See figure 13. Turn the instrument on.

   Insert Card 11, SIG. REG. AND AMPL, into the Card Switch. Connect a high-impedance, sensitive AC voltmeter from pin 3 to pin 6 on any convenient socket. NOTE: THIS MUST BE A HIGH IMPEDANCE AC VACUUM TUBE VOLTMETER, CAPABLE OF ACCURATE MEASUREMENT OF 0.222 VOLTS RMS. BALLANTINE MODEL 300 OR EQUIVALENT IS RECOMMENDED.

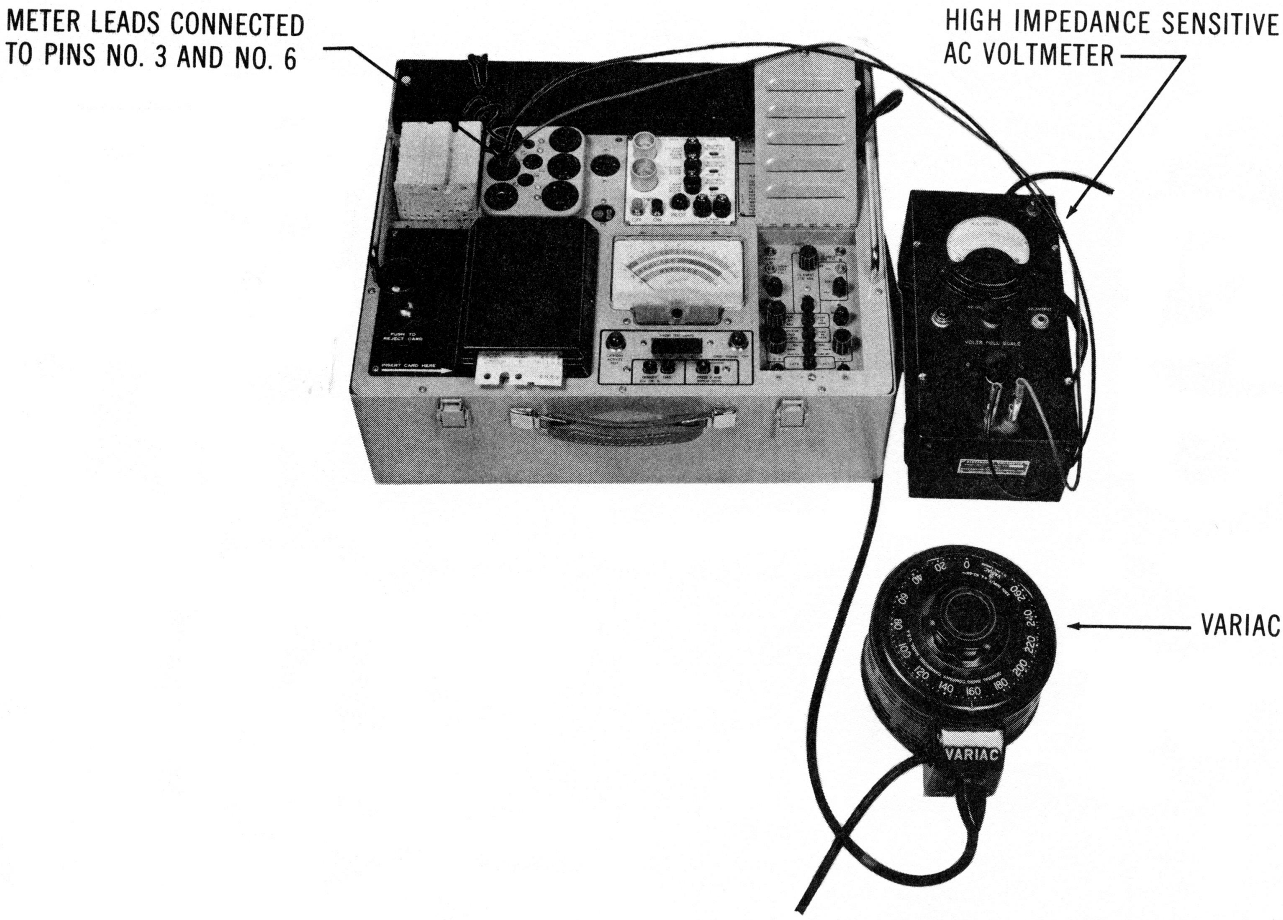



Figure 13 - Signal Regulation and Amplitude Check

b. While holding down button #2, vary the line voltage from 105 to 125 volts. Note reading indicated on the vacuum tube voltmeter. The indicated voltage at 105 and 125 should be identical and should not vary more than 1% from the indicated voltage at 115 volts line. If the circuit is not regulating as specified, adjust the SIGNAL CAL REGULATION control and vary the line voltage to attain the desired regulation.

c. After the signal regulation is properly adjusted, set the exact signal level of 0. 222 volts rms by adjusting the SIGNAL CAL AMPLITUDE control.

6. 04 Filament Standardization Adjust.

a. Method One.

Connect the instrument to the power line thru a Variac. Turn instrument on. Monitor the voltage delivered to the instrument with an AC voltmeter and adjust the Variac to deliver 115 V RMS.

Insert Card 12, FIL STD ADJUST.

Set the FILAMENT STD ADJ located in the auxiliary control compartment, to the NOM 115V position (white dot on knob lines up with dot on panel).

Press the FILAMENT STD ADJ push button. The meter should read half scale ± 1 division.

If correction is necessary adjust the FILAMENT STD CAL control located in the upper right corner of the control compartment, for proper indication

b. Method Two.

Connect the instrument to the power line and turn it on. Connect an AC voltmeter capable of accurately measuring 5 volts RMS to pins 3 and 6 on any convenient tube socket. (The Ballantine Model 300 or equivalent used for signal adjustments can also be used for this measurement.) See Figure 13.

Insert Card 12, FIL. STD. ADJ. into switch.

Set the FILAMENT STD ADJ knob so that the external AC voltmeter indicates 5 volts.

Press the FILAMENT STD ADJ push button. The tester meter should read half-scale ± 1 division.

If correction is necessary adjust the FILAMENT STD CAL control, located in the upper right corner of the control compartment, for proper indication.

6. 05 Main B+ Power Supply

a. Feedback current adjust:

Remove the black perforated cover over the power supply tubes. Remove the 6CD6, V103, and the 6AW8A, V105, from their sockets. See Figure 14. Insert Card 13, FEEDBACK B PLUS.

| |
|---|
| WARNING: BE SURE TUBES ARE REMOVED BEFORE INSERTING CARD 13. |

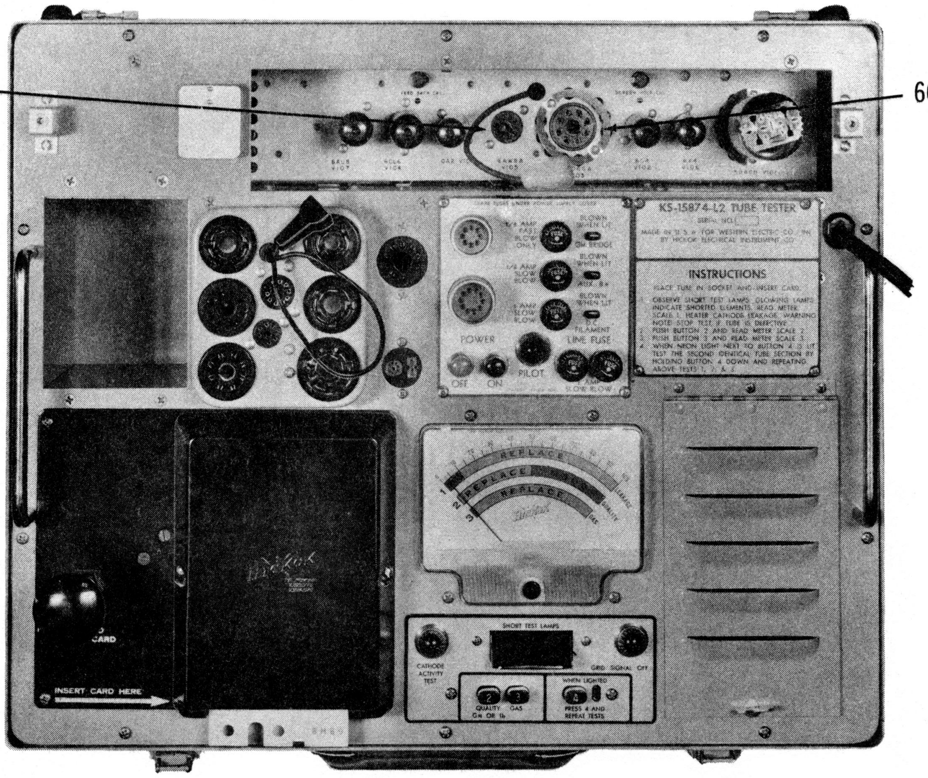



Figure 14 - B+ Power Supply Feed Back Current Test

Press button #2. The meter should read mid-scale (1MA feedback current.) If reading is not correct, adjust the FEEDBACK CURRENT ADJ. control, R123, located on the power supply chassis, for proper indication.

After proper adjustment - REMOVE CARD 13 FROM THE CARD SWITCH BEFORE RETURNING THE 6CD6 AND 6AW8A TO THEIR PROPER SOCKETS.

Insert Card #8, MAIN B PLUS CAL. Press button #2 and check for a mid-scale reading. Readjust the MAIN B+ CAL control if necessary.

b. Series Regulator Screen Voltage Adjustment.

Insert Card 14A, 6CD6 SCRN ADJUST. Press button #2. The meter reading should be approximately mid-scale. While holding down button #2, slowly rotate the SCR. ADJ. control, R109 (located on the power supply chassis) counter-clockwise until the meter indication just starts to drop from its normal mid-scale position. Then turn the control clockwise just enough to restore the mid-scale reading and leave it at this setting.

C. <u>Trouble Shooting Procedure</u>

6.06 General

As stated earlier the Model 1234A is equipped with self-calibrating features. The calibration program cards also greatly simplify the troubleshooting of the tester. The

6.07 Main B+ Power Supply Tracking.

Insert Cards 15 thru 22 successively into the card switch. Push button #2. The meter should indicate mid-scale ± 2 divisions in each case.

During these tests an accurate DC voltmeter (20,000 ohms per volt, Hickok Model 456, or equivalent) may be connected to pins 3 and 6 on any convenient socket as shown in Figure 15. The voltage readings on the external meter should be as follows:

| Card # | Indicated Voltage | Component | |
|---|---|---|---|
| 15 | 10 | R238 | 10K ± 1% |
| 16 | 20 | R239 | 20K ± 1% |
| 17 | 20 | R240 | 20K ± 1% |
| 18 | 60 | R237 | 62K ± 1% |
| 19 | 110 | R236 | 52K ± 1% |
| 20 | 160 | R235 | 52K ± 1% |
| 21 | 210 | R234 | 52K ± 1% |
| 22 | 260 | | |

If the readings are not mid-scale ± 2 divisions on the tester meter and not within 3% plus meter tolerance on the external meter, the associated resistor listed in the component column should be checked for proper value.

If the readings are improper on the tester meter while the external meter indicates proper tracking, check the meter shunts and multipliers (See Meter Circuits Checks, paragraph 6.11).

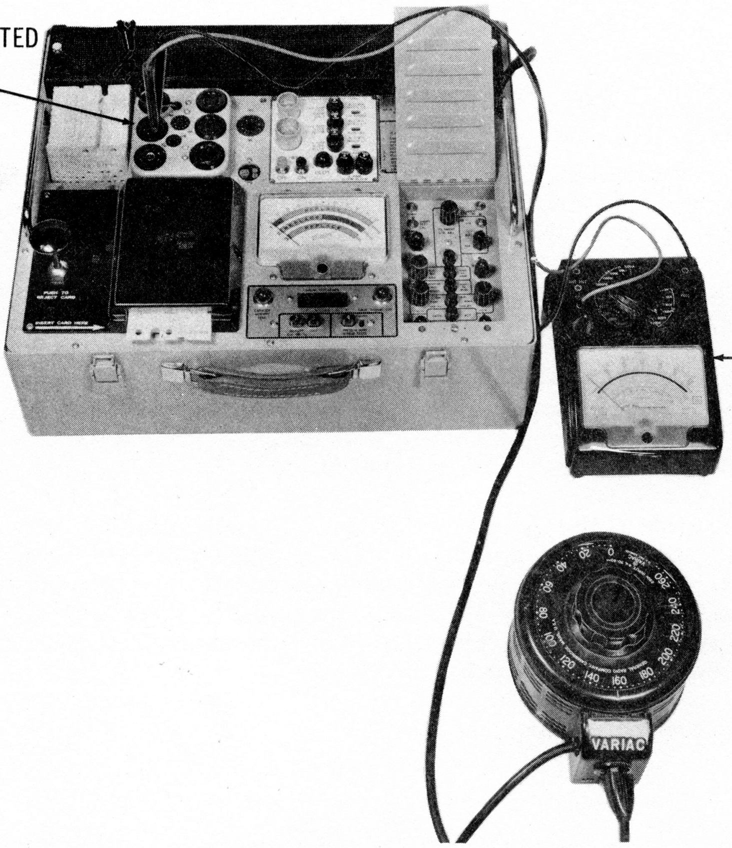



Figure 15 - Checking Main B+ Power Supply With the Aid of an External Meter

6.08 Main B+ Power Supply Regulation

Connect the tube tester to the power line through a Variac set to 115 volts. Insert Card 23, MAIN B PLUS REG. Press button #2. The tester meter should read mid-scale ± 2 divisions. Note the exact reading, then check the readings at 105 and 125 line voltages. These readings should not vary more than ± 1 division from the 115 volt indication.

Reset Variac for 105 volt line. Again note reading indicated on meter (150 volts at 1.5 MA load). While holding down button #2, press button #4 (150 volts at 140 MA load). The meter indication should not vary more than 1 division from the 1.5 MA load (button 2 only) to the 140 MA load (button #2 and #4).

If circuits are not regulating properly check tubes V103, 6CD6GA; V105, 6AW8A, (both sections), and V108, OA2. Also check for proper voltage and resistance values as listed in the Power Supply Voltage and Resistance chart, (Figure 20).

6.09 D. C. Filament-Cath. Activity Checks.

Insert Card 24, DC FIL-CATH ACT., into card switch. The left short lamp should light.

Standardize the filament supply with the FILAMENT STD. ADJ.

Press button #2. The meter should read mid-scale ± 3 div.

If reading is out of tolerance check the D. C. filament rectifiers CR-201, CR-202, CR-203, and CR-204.

Hold down button #2 and press the CATH ACT switch located in the auxiliary control compartment. The meter reading should drop 5 divisions.

6.10 Auxiliary B+ Power Supply.

Connect the tester to the power line through a Variac. Insert Card 25, AUX B PLUS REG, in card switch. Short lamps 1, 2, 3, and 5 should light.

Supply Range: Press the AUX B+ ADJ. button in auxiliary control compartment. Rotate the associated control knob thru its complete range. The tester meter indication should vary from approximately 10 on the scale to at least full scale. (Some overswing is permissible at both ends of the control adjustment).

Voltmeter Circuit: While still pressing the AUX B+ ADJ. button set the control to give a mid-scale reading on the meter. Release the AUX B+ ADJ. button and press button #2. The meter should read mid-scale ± 2 division. This is a check of the auxiliary B+ supply metering circuit which is separate from the main metering circuits. If the reading is out of tolerance, check R-320, 3 megohm ± 1%.

Line Regulation: While holding down button #2 vary the line voltage from 115 to 125 then to 105. The meter readings at 105 and 125 volts should not vary more than ± 3 divisions from the reading at 115 volts line.

Load Regulation: Set line voltage at 105 volts. Push button #2. Note the reading on the meter (it should still be at mid-scale, from the previous steps). This is a 150 volt indication at a low output current. While holding button #2, press button #4. The meter will indicate the output voltage with rated output current being drawn from the supply. The deviation between the two readings should not exceed ± 3 divisions.

If indications during the above tests are not proper, check V106, 6X4; V104, 6CL6; and V107B, 6AU8 pentode section. Also check voltage and resistances at tube sockets against values listed in the voltage and resistance chart.

If desired a 20,000 ohms per volt meter (Hickok Model 456 or equivalent) may be connected from pin 3 (+) to pin 6 (-) on any convenient socket to externally monitor the same output voltage being measured on the tester meter.

### 6.11 Meter Circuit Checks

The first test in Routine Calibration, together with the Trouble Shooting procedure listed below, form complete tests of the basic meter sensitivity, the meter shunts and the meter multipliers.

Each of these tests is designed to check a particular "primary component". However, additional components are also used in the test circuit and are "secondary components" in each test.

The following table lists the test card number, function, the primary component number and values, and the secondary components involved. When a number of tests give improper readings a comparison of the primary and secondary components involved will help isolate the defective part. Questionable parts can then be checked with a resistance bridge or an accurate ohmmeter. In each of the following tests insert the proper card in the switch press button #2. The meter should read mid-scale ± 2 divisions.

| Card No. | Primary Component | Secondary Components |
|---|---|---|
| | Meter Shunts | |
| 26 | R207, 1280Ω± 1% | R206, R215, R216, R218, R226, R270, R241 |
| 27 | R208, 640Ω± 1% | R206, R216, R-219, R223, R224, R225 |
| 28 | R209, 320Ω± 1% | R206, R217, R220, R222, R-223 |
| 29 | R210, 160Ω± 1% | R206, R216, R221, R225 |
| 30 | R211, 80Ω± 1% | R206, R215, R216, R219, R226 |
| 31 | R212, 40Ω± 1% | R206, R215, R216, R218, R220, R221 |
| 32 | R213, 20Ω± 1% | R206, R216, R219, R223, R225, R241 |
| 33 | R214, 10Ω± 1% | R206, R219, R224, R241 |
| | Meter Multipliers | |
| 34 | R206, 25,344Ω± 1% | |
| 35 | R241, 1067Ω± 1% | R206 |
| 36 | R230, 100K ± 1% | |

6.12 Decade Resistor Checks

The following tests are similar to the Meter Circuit checks listed above except that the decade resistors are the "Primary Components". The "Secondary Components" involved are also listed.

a. Procedure for test cards 37 through 40:

Insert proper card into card switch, the left three short lamps should light. Press the FILAMENT STD ADJ. push button and set FILAMENT STD. ADJ switch for mid-scale indication on the tester meter. Press button #2, meter should read mid-scale ± 2 divisions.

| Card No. | Primary Component | Secondary Component |
|---|---|---|
| 37 | R218, 10 Ω ± 1% | R206, R210, R213, R214 |
| 38 | R217, 20 Ω ± 1% | Same as card 35 |
| 39 | R216, 30 Ω ± 1% | Same as card 35 |
| 40 | R215, 40 Ω ± 1% | Same as card 35 |

b. Procedure for test cards 41 and 42:

Insert proper test card into card switch. The left three short lamps should light. Press the FILAMENT STD ADJ push button and set FILAMENT STD ADJ switch for mid-scale indication on the tester meter. Press button #2. The tester meter should indicate mid-scale ± 2 divisions.

| Card No. | Primary Component | Secondary Component |
|---|---|---|
| 41 | R219, 100 Ω ± 1% | R206, R210, R213, R214 |
| 42 | R220, 200 Ω ± 1% | R206, R210, R213, R214 |

c. Procedure for test cards 43 through 48:

Insert proper test card. The extreme left short lamp should light. Press button #2. Read mid-scale ± 2 divisions.

| Card No. | Primary Component | Secondary Component |
|---|---|---|
| 43 | R221, 300 Ω ± 1% | R206, R208, R209, R210 R211, R212 |
| 44 | R222, 400 Ω ± 1% | R206, R207, R208, R209, R210, R212 |
| 45 | R226, 1000 Ω ± 1% | R206, R207, R208, R211 |
| 46 | R225, 2000 Ω ± 1% | R206, R207, R208, R209, R213, R214 |
| 47 | R224, 3000 Ω ± 1% | R206, R209, R214, R241 |
| 48 | R223, 4000 Ω ± 1% | R206, R207, R208, R212, R213, R241 |

d. Procedure for test Cards 49 thru 51 is the same as above except tolerance is mid-scale ± 4 divisions.

| Card No. | Primary Component | Secondary Component |
|---|---|---|
| 49 | R227 & R231 in parallel 10K ± 5% | R207, R208, R213, R214 |
| 50 | R228, 20K ± 5% | R207, R208, R209, R210, R211, R213 |
| 51 | R229, 30K ± 5% | R208, R209, R210, R211 R212 |

6. 13 Main B+ Protection

The tester meter and the main B+ supply are protected against overloads by means of a slave relay protective circuit whose primary components are a line slave relay K101 and two reed relays K102 and K104. (See Section 5. 21 and Figure 16). Cards 52A and 53A are used to check out part of this circuit as follows:

Insert Card 52A B+ PROTECTION, NO GO. Short lamps 1 and 2 should light. Press button #2. This applies a heavy load to the main B+ supply. The load is not excessive and should not shut off the tester.

Insert Card 53A B+ PROTECTION, GO. Short lamps 1 and 2 should glow. Press button #2. This applies an excessive load to the main B+ supply. The tester should shut off.

If either of these cards does not operate correctly, check reed relay K102, capacitor C111 and resistor R160.

6. 14 Slave Relay Protective Circuit

If the tester shuts off after the tubes heat up and will not remain on after again pressing the ON-OFF switch, the trouble may be in the slave relay protective circuit and can be located by the following procedure:

While pressing the ON-OFF switch S105 in the ON position, check the voltage across the slave relay operating coil K101. This should be about 3 volts D. C. If this voltage is not present, the coil of the relay is probably being shorted out by a reed relay K102 or K104 (See Figure 15).

The operating coil of reed relay K102 is in the plate circuit of the 6CD6, V103, and therefore all main B+ current must pass through this coil. Any faulty conditions in the power supply which cause the current to be excessive will close the reed relay contacts and short out the slave relay K101. The power supply voltage and resistance chart (Figure 19) can be helpful in locating this type of trouble.

Reed relay K104 contains 2 coils. One of these is a hold coil which is energized at all times by means of the -150 volt supply. The current in this coil is maintained slightly less than that necessary to close the reed relay contacts. If the -150 volt supply is operating incorrectly and allowing a voltage more negative than -150 volts, this may cause the reed relay K104 contacts to close. This trouble also can be found by using the voltage and resistance chart (Figure 19).

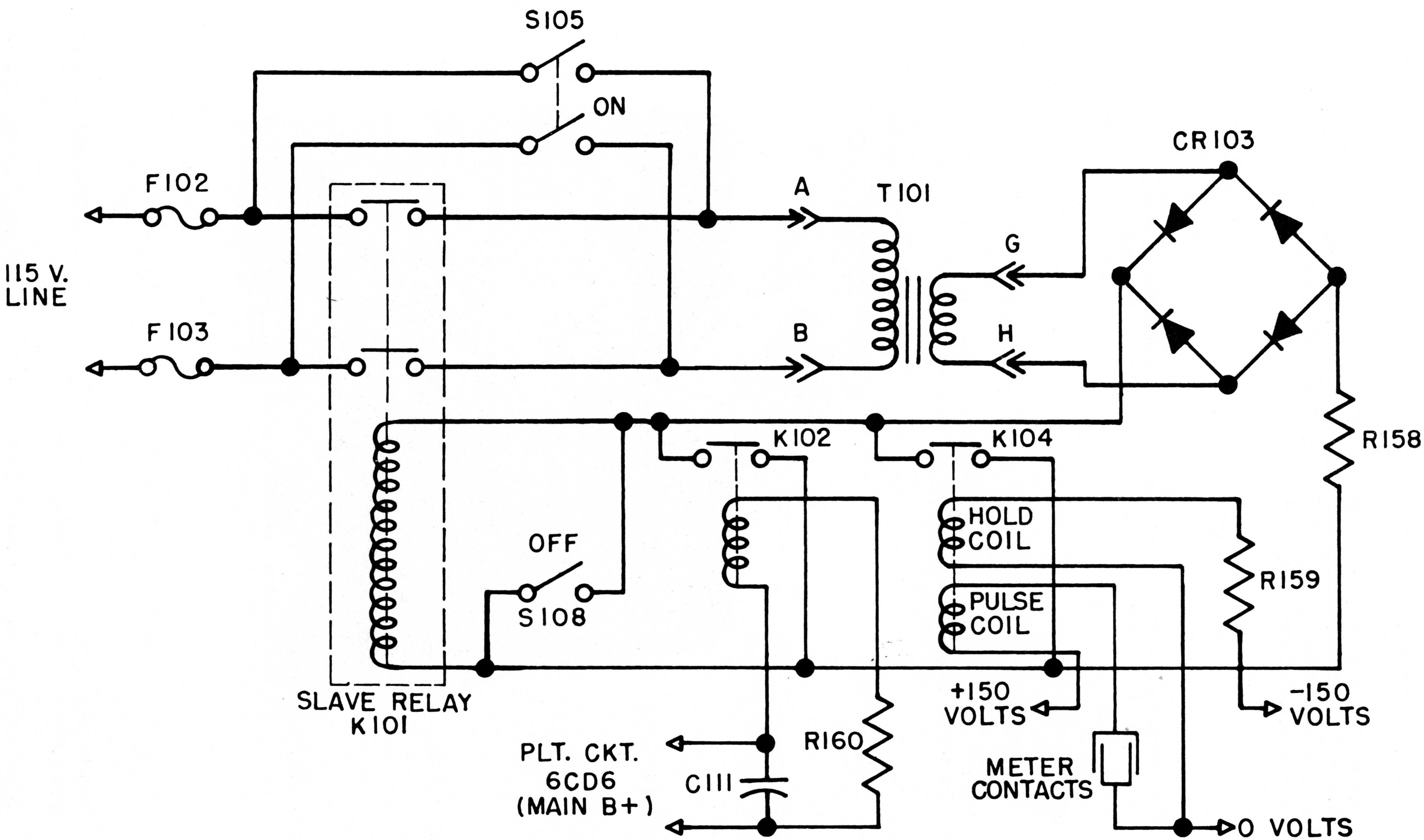



Figure 15 - Slave Relay Protective Circuit

6.15 Adjustment of upper microswitch

The microswitch is adjusted at the factory prior to shipment, consequently adjustment should not be attempted unless absolutely necessary. There are two ways in which to properly adjust the microswitch. The first procedure requires two 1/8" diameter pins, but is more accurate than the second procedure

WARNING

High Voltage is present across upper micro switch terminals.
Disconnect line cord from power source before adjustment.

a. First Procedure:

1. Remove card switch cover and insert non-test code card into card switch.

2. Insert two .125 inch diameter (1/8 inch diameter) pins or drill shanks into the switch plate holes A-1 and L-1 to retain the code card (See figure 16).

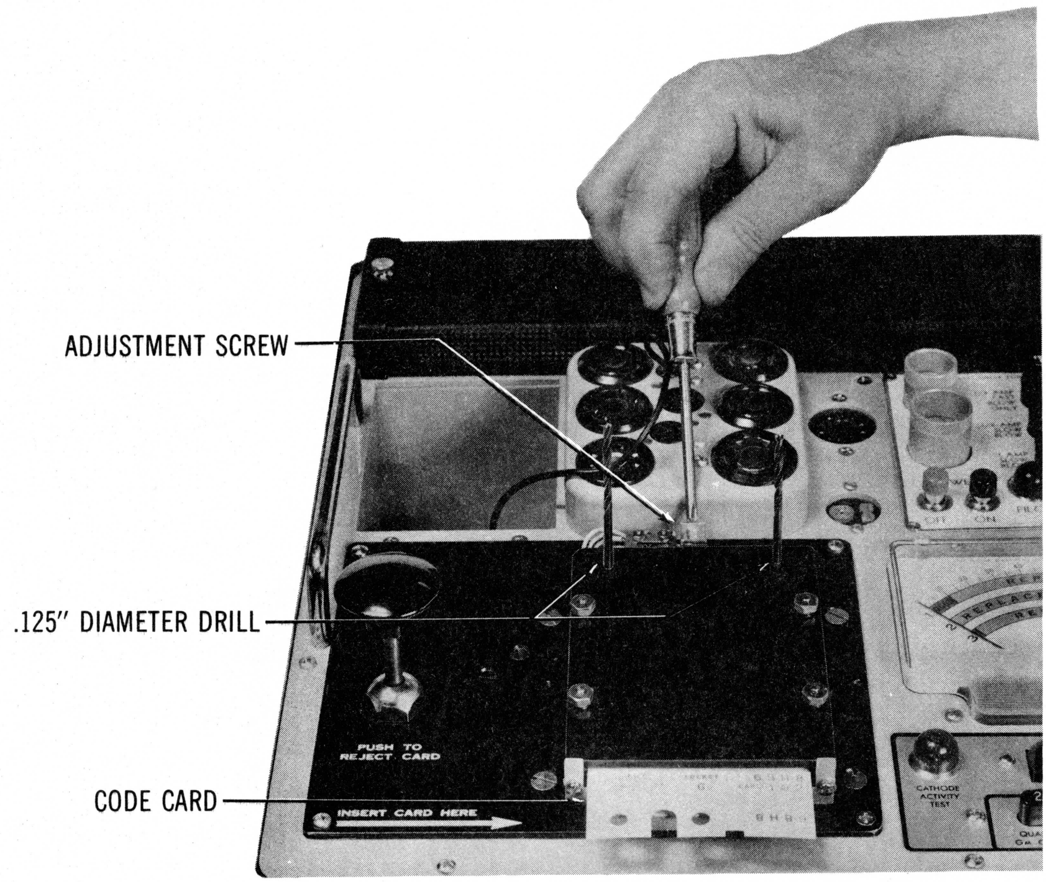



Figure 16 - Adjustment of Upper
Micro Switch

3. Gently pull on the code card to remove all clearance between the two pins and holes A-1 and L-1 in the code card.

4. Adjust the microswitch inward (toward the card switch) with the adjustment

screw (see Figure 17) until the micro switch actuates (an audible CLICK can be heard).

5. Reverse direction of the adjustment screw and move the micro switch out until it de-actuates (an audible CLICK will be heard). Approximately 1/2 turn of the adjustment screw will be necessary to de-activate a properly operating microswitch.

6. Connect tester to power source and press ON switch. Retest the action of the switch with the code card. Replace the card switch cover.

b. Second Procedure:

1. Remove card switch cover and insert code card into card switch.

2. Observe the code card holes through the row 1 holes in the top switch plate. The code card material should just disappear (.005 inch) at the top of the row 1 switch plate holes when the micro switch actuates (an audible CLICK will be heard). If adjustment is necessary, turn the adjustment screw. (See figure 19) until alignment is correct.

3. Connect the tester to power source and press ON switch. Retest the action of the switch with the code card. Replace the card switch cover.

6.16 Adjustment of Contact Pins

If code card will not come out of card switch when reject knob is pressed, a contact pin has moved above its normal position and is projecting through a hole in code card. Correct as follows:

a. Disconnect power source line cord. Remove switch cover.

b. Inspect tops of contact pins to see if one or more has moved above normal position. Use probe and carefully push pin or pins down until they clear code card.

c. Connect power source line cord and press ON switch. Reactivate card switch several times with same code card. Card must slide out each time reject knob is pressed.

D. Miscellaneous Parts Replacement

6.17 Replacement of Parts. The replacement instructions contained herein are limited to high mortality parts which are in some way unusual in installation. When trouble shooting procedures reveal defective parts and replacement is necessary, every effort must be made to duplicate original condition of equipment. Recalibrate tube tester after replacement of parts to assure accuracy of tube test readings.

6.18 Replacement of Tubes. Exercise care when removing or installing electron tubes to assure high quality performance from associated circuits. Observe handling precautions which are common to all vacuum tubes.

6.19 Replacement of Diodes. The diodes (CR401, CR402, CR403 and CR404 (Schematic Sheet 2), mounted on the terminal board are either matched pairs or all four are matched together and must be replaced as matched units. They shall be physically mounted in the same manner as those which are removed. Note direction of arrow printed on diodes and position replacement part in identical relationship to terminals.

C A U T I O N

Do not overheat diodes during soldering operation. Hold lead wire with pliers positioned between diode body and point being soldered.

6. 20 Replacement of Upper Micro-Switch. (See Figure 17). Unsolder leads from terminals on micro-switch. Remove nuts, washers and screws securing micro-switch to bracket. Remove microswitch. Exercise care not to lose small actuating pin in card switch. Install new micro-switch in reverse order of removal procedure.

6. 21 Replacement of Lower Micro Switch. Remove screws and spacers securing terminal board to card switch. Lift terminal board away from card switch to gain access to lower micro switch. Unsolder leads to micro switch terminals. Remove nuts, washers, screws and defective micro switch. Position new micro switch in place and install it in reverse order of removal procedure. Check to see that switch actuating screw engages micro switch as required when card-reject knob is pressed. If adjustment is required, loosen lock nut, make adjustment, and retighten lock nut.

6. 22 Replacement of Card Switch Solenoid. (See Figure 18). Unsolder leads to terminals on solenoid. Disengage spring from clip on plunger and remove cotter pin and clip. Remove screws from face of panel and disengage solenoid from solenoid actuating arm. Install new solenoid and reconnect associated parts in the reverse order of removal.

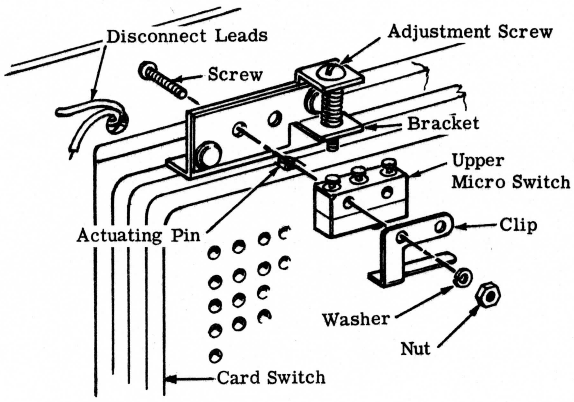



Figure 17 - Replacement of Upper Micro Switch

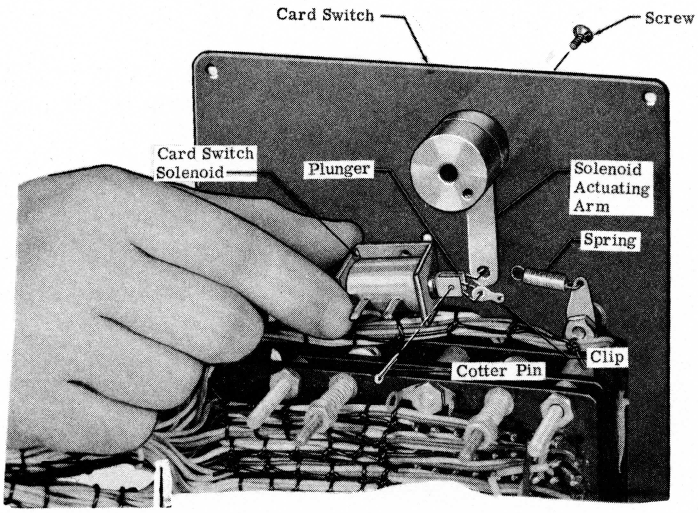



Figure 18 - Replacing Card Switch Solenoid

6. 23 Figures 22 through 29 have been provided to aid in the location of components.

1. Voltages & Resistance at socket contacts (Power Supply) with zero volts as reference point.
2. Pin #1 or OA 2 socket = Zero. Input = 115 Volts
3. Maintenance Card #23 in Switch. #2 Button pressed. Aux. B+ Supply set to 150 Volts (mid-scale on meter when Aux B+ Button is Pressed)

POWER SUPPLY KS-15874

SOCKET PIN NO.

| TUBE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 6AU8 | 0 (0 Ω) | -40 (3M Ω) | 230.0 (70K Ω) | 3.1 AC (0 Ω) | 3.1 AC (0 Ω) | -86.0 (40K Ω) | -87.0 (160K Ω) | -28.0 (115K Ω) | 97.0 (10M Ω) |
| 6CL6 | 150.0 (650K Ω) | 100.0 (10M Ω) | 405.0 (95K Ω) | 150.0 (650K Ω) | 150.0 (650K Ω) | 405.0 (95K Ω) | 150.0 (650K Ω) | NC | NC |
| OA 2 | 0 (0 Ω) | NC | NC | -150.0 (34K Ω) | NC | NC | -150.0 (34K Ω) | -- | -- |
| 6AW8 A | -99 (50K Ω) | -100 (63K Ω) | 0 (0 Ω) | 3.1AC (0 Ω) | 3.1AC (0 Ω) | -100.0 (60K Ω) | -100.0 (70K Ω) | -55.0 (60K Ω) | 121.0 (600K Ω) |
| 6CD6 GA | NC | 156.0 (80K Ω) | 150.0 (80K Ω) | 198.0 (450K Ω) | 121.0 (580K Ω) | NC | 150.0 (80K Ω) | 275.0 (Infinity Ω) | -- |
| 6C4 | 400.0 (95K Ω) | NC | 150.0 (80K Ω) | 150.0 (80K Ω) | 400.0 (95K Ω) | 260.0 (350K Ω) | 275.0 (Infinity Ω) | -- | -- |
| 6X4 | 305.0AC (73 Ω) | NC | 150.0 (660K Ω) | 150.0 (660K Ω) | NC | 305.0 AC (73 Ω) | 406.0 (100K Ω) | -- | -- |
| 5U4 GB | NC | 370.0 (510K Ω) | NC | 260.0 AC (67 Ω) | NC | 260.0 AC (67 Ω) | NC | 370.0 (510K Ω) | -- |

Figure 19 - Voltage and Resistance Data

## CALIBRATION AND MAINTENANCE TEST CARDS

| | | |
|---|---|---|
| CARD | 1 | METER |
| CARD | 2 | SHORTS 2 MEG NO GO |
| CARD | 3 | SHORTS 1 MEG GO |
| CARD | 4 | SHORTS 20 MEG NO GO |
| CARD | 5 | SHORTS 10 MEG GO |
| CARD | 6 | FIXED BIAS CAL NEG |
| CARD | 7 | FIXED BIAS CAL POS |
| CARD | 8 | MAIN B PLUS CALIB |
| CARD | 9 | GM BAL LOW IB |
| CARD | 10 | GM BAL HI IB |
| CARD | 11 | SIG REG AND AMPL |
| CARD | 12 | FIL. STAND. ADJUST |
| CARD | 13 | FEEDBACK B PLUS |
| CARD | 14A | 6CD6 SCRN ADJUST |
| CARD | 15 | MAIN B PLUS 10 V |
| CARD | 16 | MAIN B PLUS 20 V |
| CARD | 17 | MAIN B PLUS 20 V |
| CARD | 18 | MAIN B PLUS 60 V |
| CARD | 19 | MAIN B PLUS 110 V |
| CARD | 20 | MAIN B PLUS 160 V |
| CARD | 21 | MAIN B PLUS 210 V |
| CARD | 22 | MAIN B PLUS 260 V |
| CARD | 23 | MAIN B PLUS REG |
| CARD | 24 | DC FIL-CATH ACT. |
| CARD | 25 | AUX B PLUS REG. |
| CARD | 26 | METER SHUNT 1280 |
| CARD | 27 | METER SHUNT 640 |
| CARD | 28 | METER SHUNT 320 |
| CARD | 29 | METER SHUNT 160 |
| CARD | 30 | METER SHUNT 80 |
| CARD | 31 | METER SHUNT 40 |
| CARD | 32 | METER SHUNT 20 |
| CARD | 33 | METER SHUNT 10 |
| CARD | 34 | METER MULT 25344 |
| CARD | 35 | METER MULT 1067 |
| CARD | 36 | METER MULT 100K |
| CARD | 37 | DECADE RES. 10 |
| CARD | 38 | DECADE RES. 20 |
| CARD | 39 | DECADE RES. 30 |
| CARD | 40 | DECADE RES. 40 |
| CARD | 41 | DECADE RES. 100 |
| CARD | 42 | DECADE RES. 200 |
| CARD | 43 | DECADE RES. 300 |
| CARD | 44 | DECADE RES. 400 |
| CARD | 45 | DECADE RES. 1000 |
| CARD | 46 | DECADE RES. 2000 |
| CARD | 47 | DECADE RES. 3000 |
| CARD | 48 | DECADE RES. 4000 |
| CARD | 49 | DECADE RES. 10K |
| CARD | 50 | DECADE RES. 20K |
| CARD | 51 | DECADE RES. 30K |
| CARD | 52A | RELAY NO GO |
| CARD | 53A | RELAY DC GO |

Figure 20 - List of Calibration & Test Cards Furnished

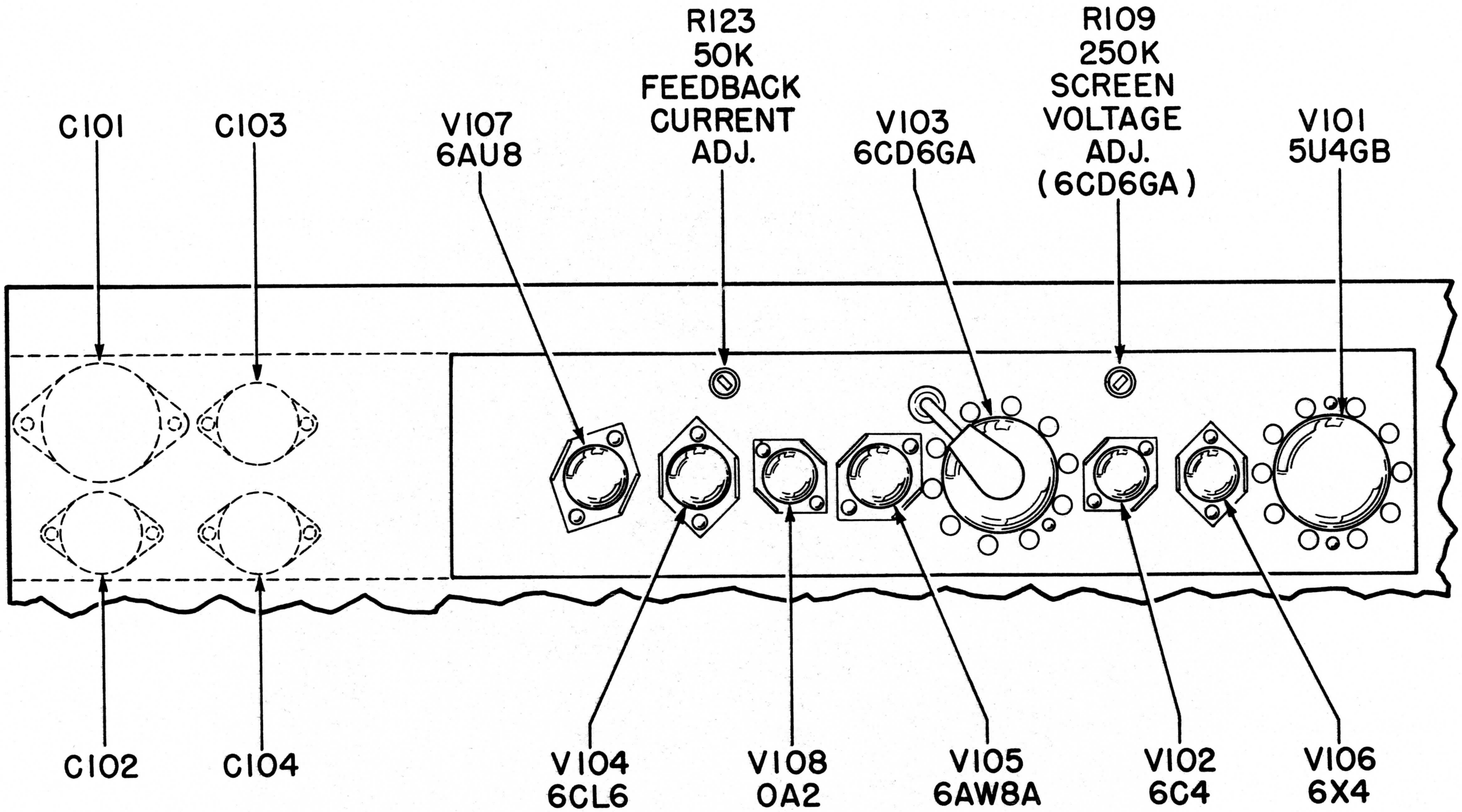



Figure 22 - Placement of Tubes, Controls
and Filter Condenser

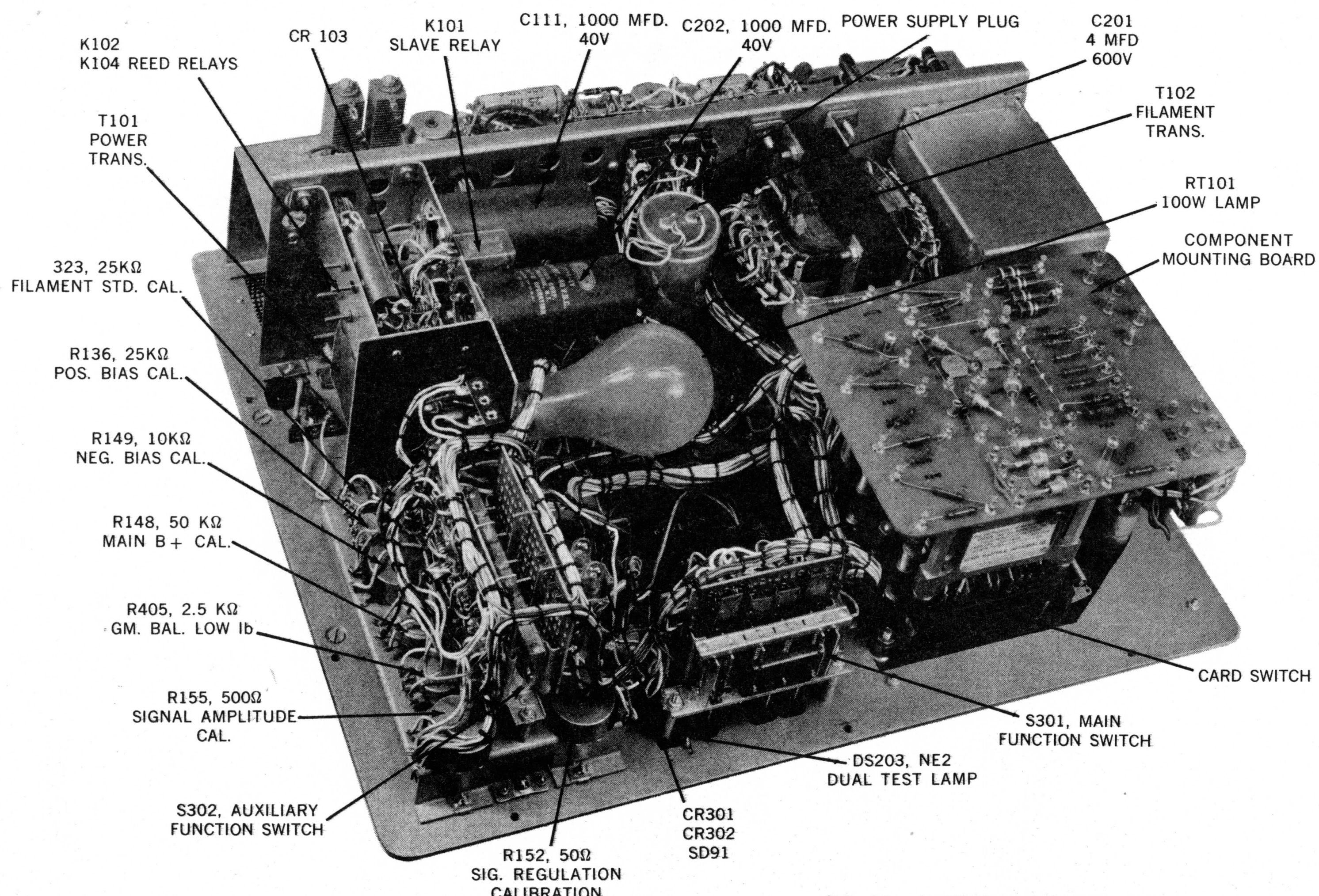



FIG. 23.—ASSEMBLY IDENTIFICATION AND MISCELLANEOUS PARTS

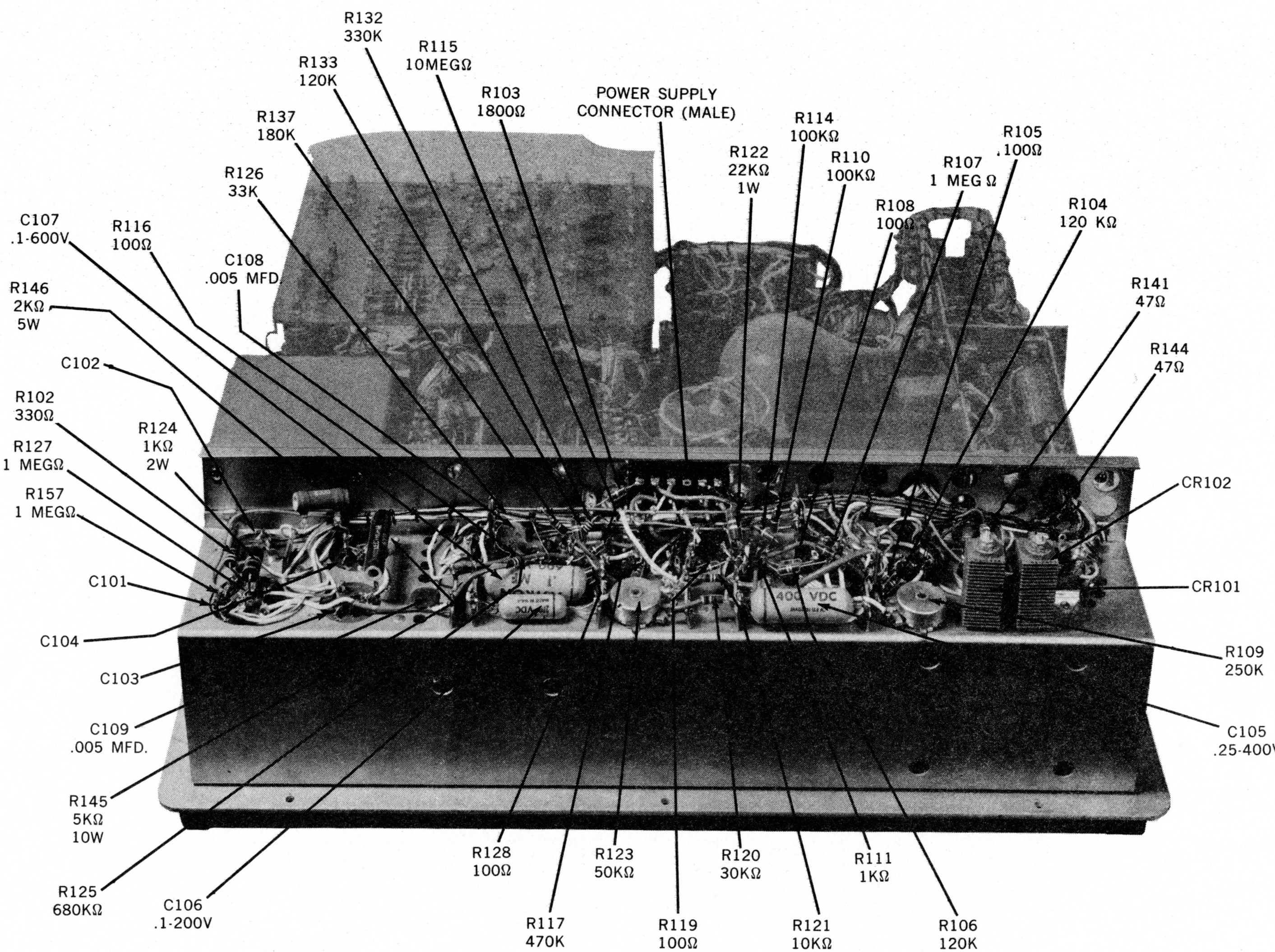



FIG. 24.—POWER SUPPLY COMPONENT LOCATION

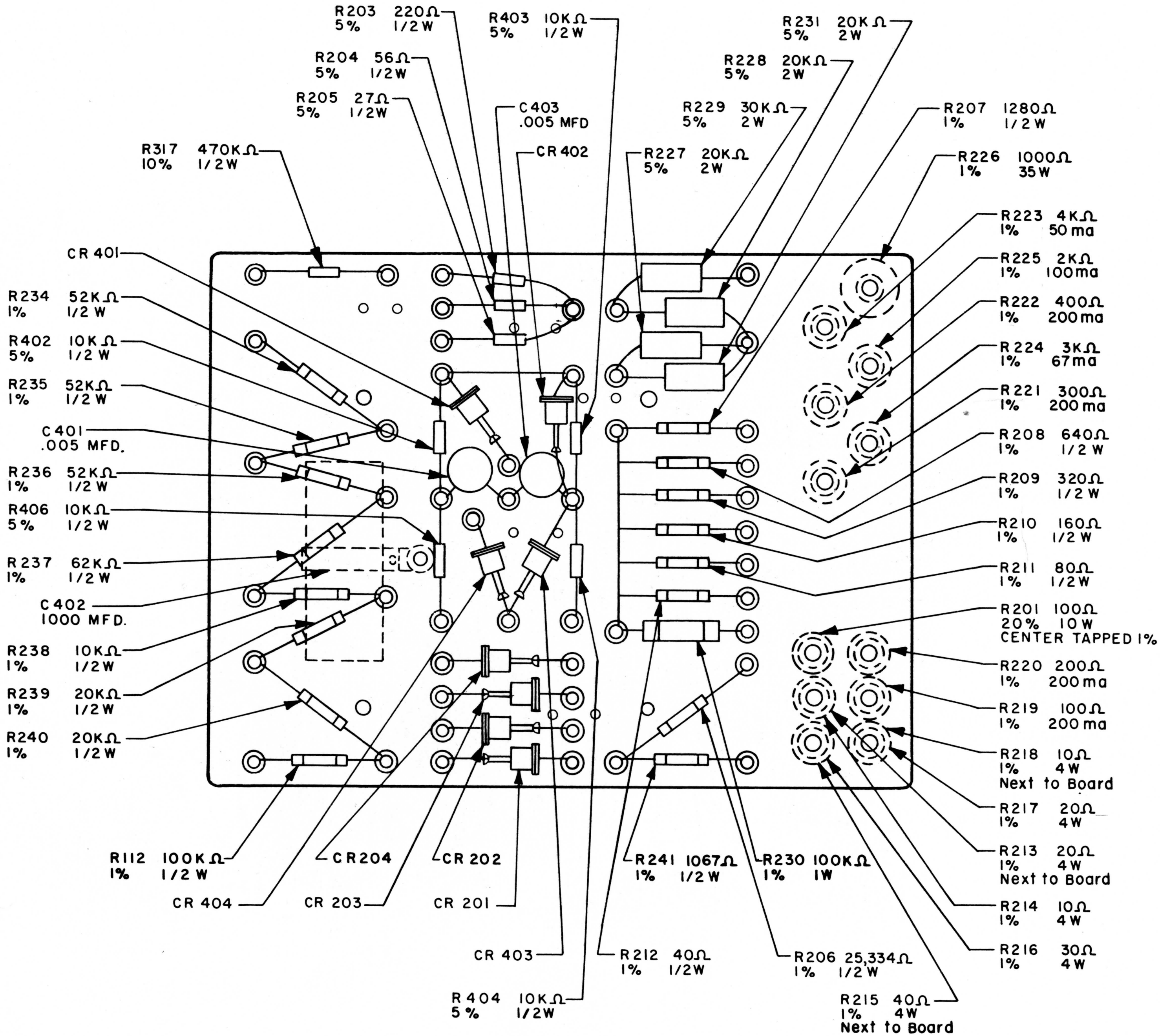



Figure 25 - Component Mounting Board

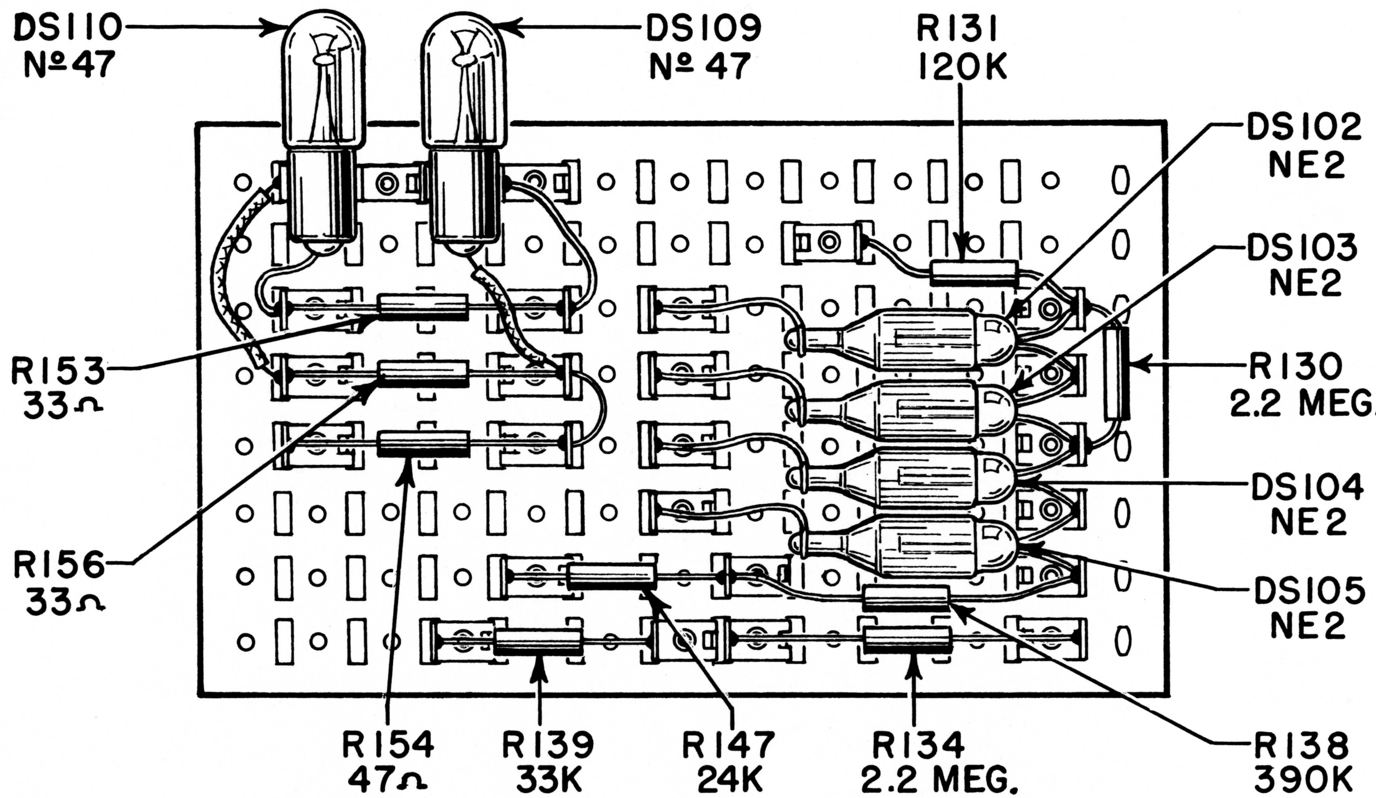



Figure 26 - Auxiliary Function Switch - Inside View

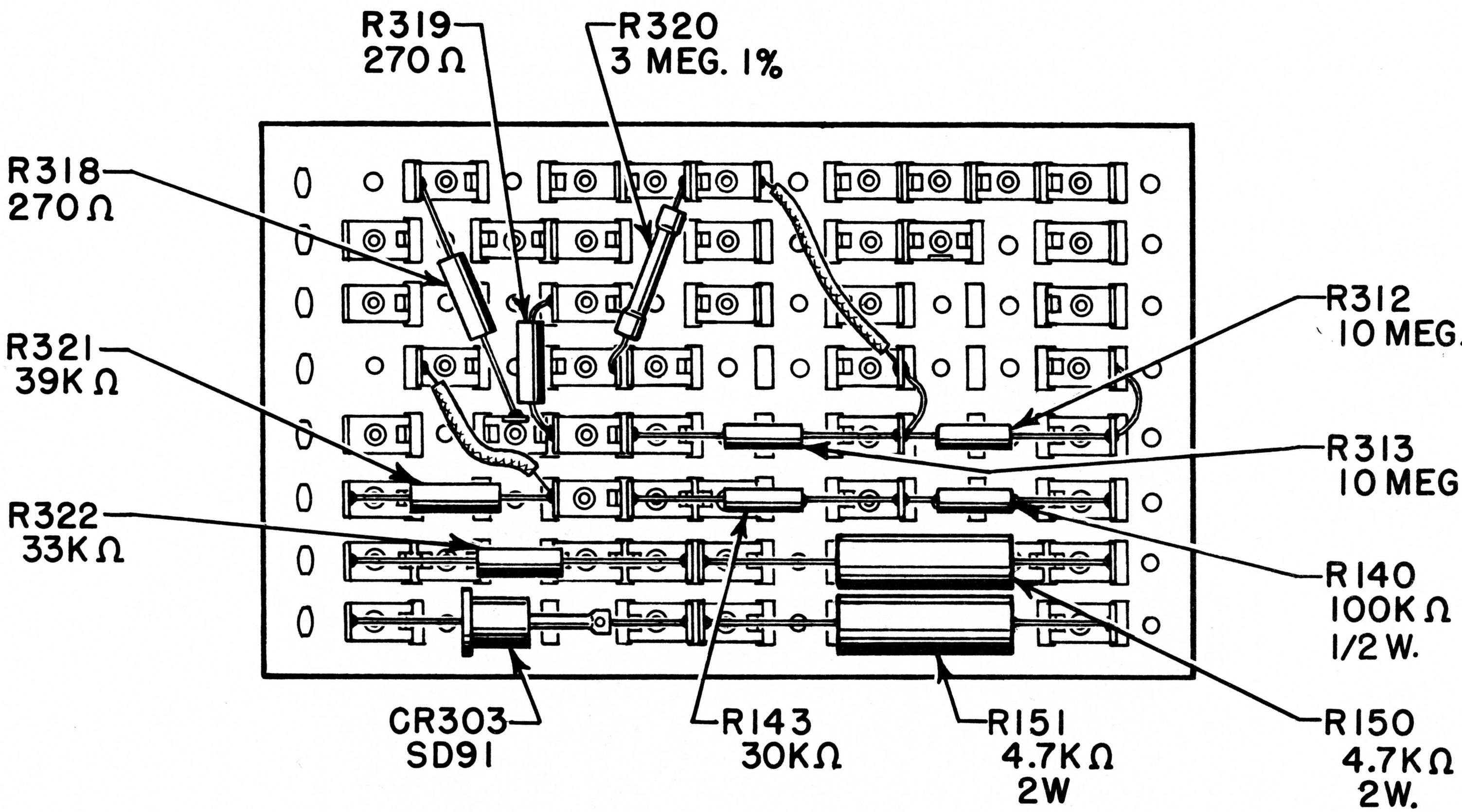



Figure 27 - Auxiliary Function Switch - Outside View

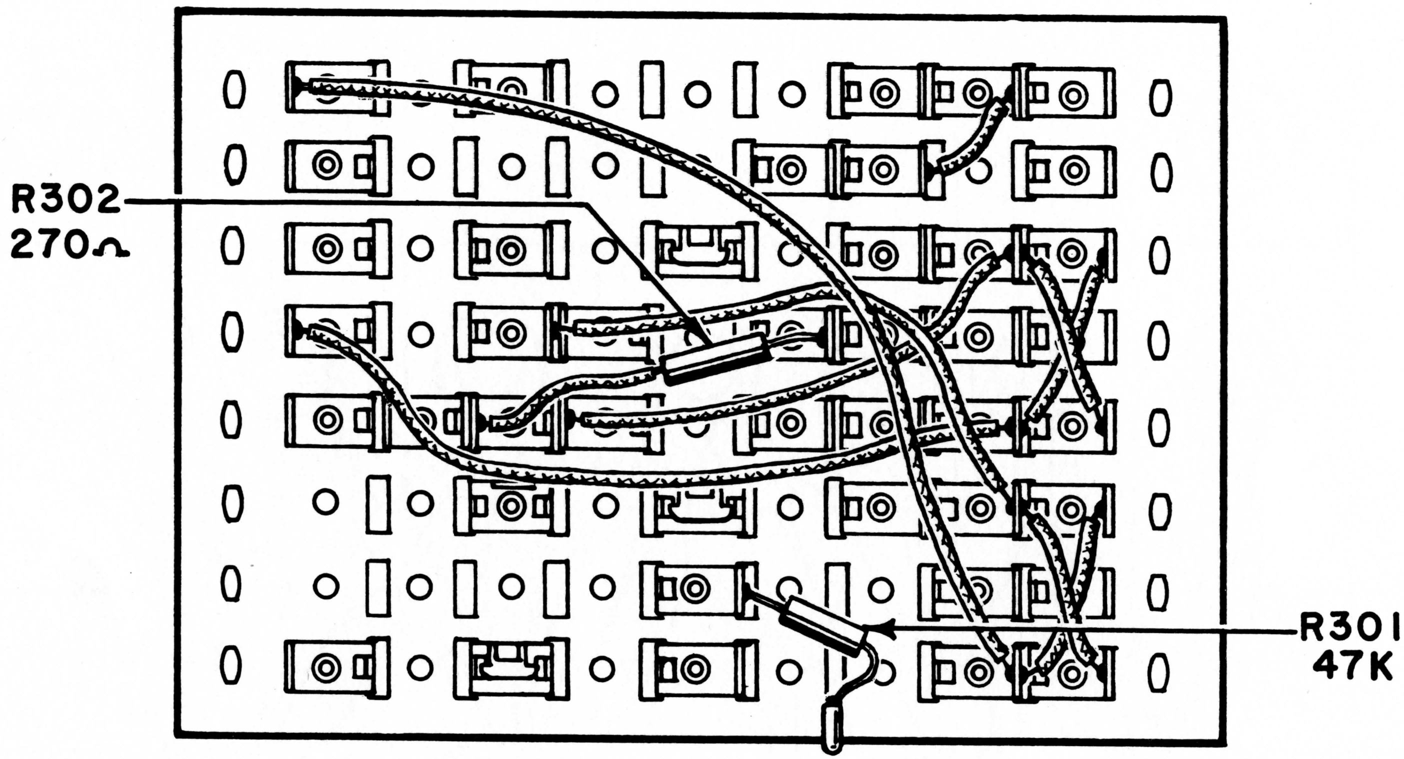



Figure 28 - Main Function Switch

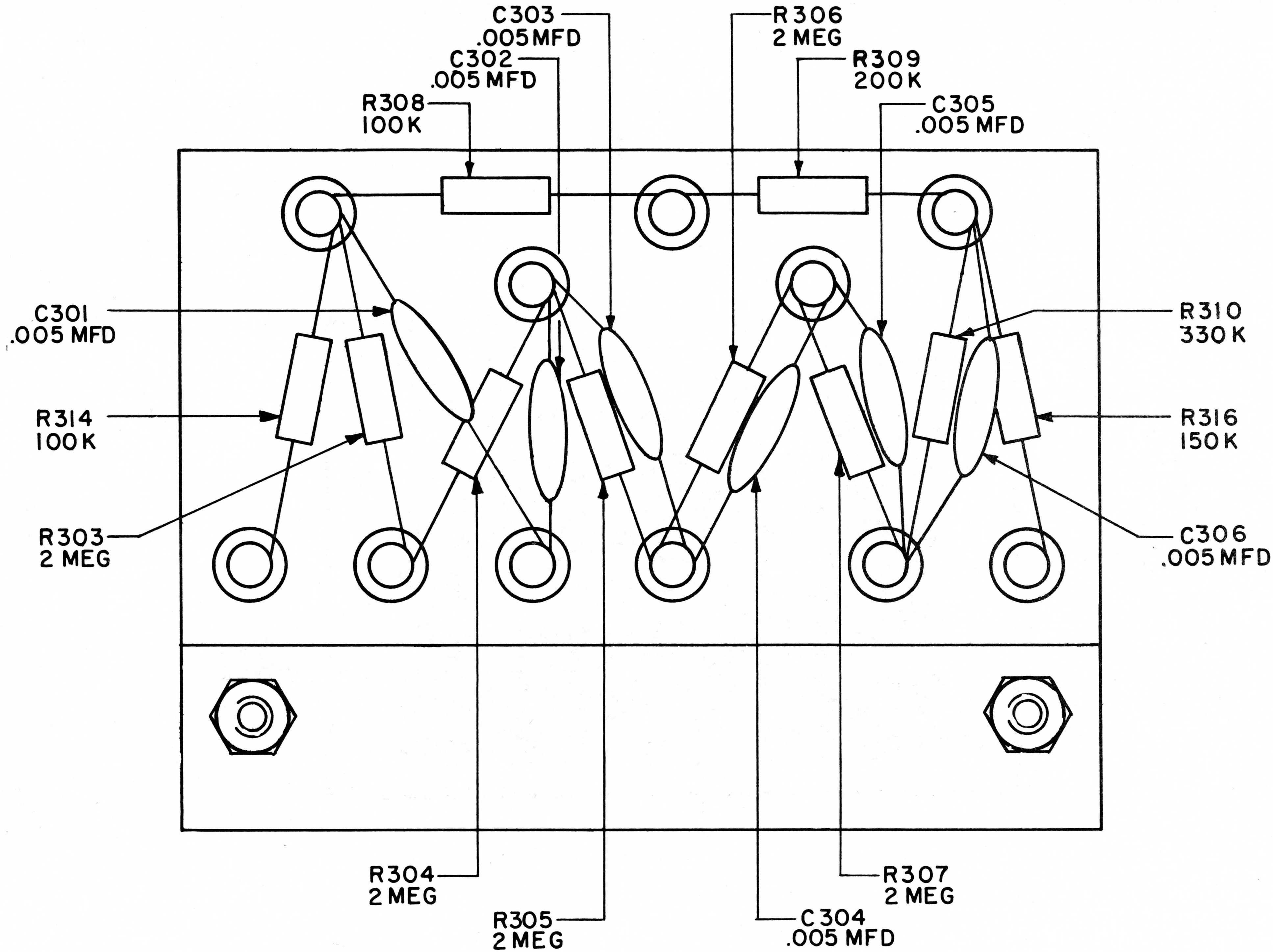



Figure 29 - Short Test Assembly

MODEL KS-15874-L2

To facilitate identification and circuit location consult the following tables.

Highest numbered reference symbols used on Drawing 1002W:

| Sheet 1 of 4 | Sheet 2 of 4 | Sheet 3 of 4 | Sheet 4 of 4 |
|---|---|---|---|
| C111<br>CR104<br>DS110<br>F103<br>K104B<br>L101<br>R162<br>RT101<br>S302E<br>T102<br>V108 | C403<br>CR404<br>DS203<br>F202<br>R406<br>S302E<br>T102 | C306<br>CR303<br>DS305<br>M301<br>R324<br>S302C<br>X302 | W401<br>X408 |

The following symbols have not been used in Drawing 1002W.

Up to C101,
C112 thru C200,
C203 thru C300,
C307 thru C400.

Up to CR101,
CR105 thru CR200,
CR205 thru CR300,
CR304 thru CR400.

Up to DS101,
DS111 thru DS200,
DS204 thru DS300.

Up to F101,
F104 thru F200.

Up to K101,
K103.

Up to L101.

Up to M301

Up to R101,
R161 thru R200,
R202,
R243 thru R300,
R325 thru R400.

Up to RT101.

Up to S102,
S104, S107,
S109 thru S300.

Up to T101.

Up to V101.

Up to W401.

Up to X301,
X303 thru X400.

## PARTS LIST

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| M-301 | 660-135 | METER: 66W Microammeter, 0-100 micro-amps | 1 |
| | 906-017 | CARD SWITCH: | 1 |
| | 2490-417 | BOOKLET: Instruction | 1 |
| | 3047-1 | CALIBRATION CELL: (Meter & Short Test Sensitivity) | 1 |
| CR-104 | 3870-89 | CRYSTAL: Diode, 1N1697 | 1 |
| CR-401 thru CR-404 | 3870-90 | CRYSTAL: matched set of 4 | 1 |
| DS-109, DS-110 | 12270-35 | LAMP: aged #47 | 2 |
| DS-301 thru DS-305 | 12272-2 | LAMP: matched set of 5 NE-2, aged, striking voltage of all 5 must be within 2 VDC of each other | 1 |
| DS-101 thru DS-105 DS-201 thru DS-203 | 12270-43 | LAMP: aged neon, NE2 | 1 |
| | 12450-238 | LEAD ASSEMBLY | 1 |
| K102 | 18400-17 | RELAY: Reed | 1 |
| K104 | 18400-18 | RELAY: Reed | 1 |
| K101 | 18400-22 | RELAY: Slave | 1 |
| V-101 | 20878-141 | TUBE: 5U4GB, tested | 1 |
| V-102 | 20878-62 | TUBE: 6C4, tested-aged-tested | 1 |
| V-103 | 20878-154 | TUBE: 6CD6GA, tested-aged-tested | 1 |
| V-104 | 20878-105 | TUBE: 6CL6, tested-aged-tested | 1 |
| V-105 | 20878-138 | TUBE: 6AW8A, tested, aged-tested | 1 |
| V-106 | 20878-68 | TUBE: 6X4, tested | 1 |
| V-107 | 20878-143 | TUBE: 6AU8, tested-aged-tested | 1 |
| V-108 | 20878-78 | TUBE: OA2, tested | 1 |
| | 2250-1 | BEAD: anti-parasitic, General Ceramics and Steatite Corp. #Feramic Q Material in accordance with Dwg. #F754/ | 64 |
| | 2920-7 | BUTTON: push, black | 3 |
| | 2920-8 | BUTTON: push, red | 2 |
| | 2920-11 | BUTTON: molded, push, oval, Harry Davies No. 5149-A, Stamped #2, black phenolic | 1 |
| | 2920-12 | BUTTON: molded, push, oval, Harry Davies No. 5149-A, stamped #3, black phenolic | 1 |
| | 2920-15 | BUTTON: molded, push, oval, Harry Davies No. 5149-A, stamped #4, red phenolic | 1 |
| | 3075-28 | CAP: Potentiometer D. and M. Products, Item CGB, black bakelite | 5 |
| C-201 | 3105-263 | CAPACITOR: paper, 4 μfd, 600 volt, Astron ARH-5744 (metal can) supplied with mtg. clamp 3275-266 unassembled | 1 |
| C-202 C-111 | 3085-79 | CAPACITOR, electrolytic: 1000 μfd, 40 volts, 1-3/8" x 3", supplied with insulating sleeve | 2 |

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| C-402 | 3085-101 | CAPACITOR, electrolytic: 1000 µfd, 6 volt, axial wire leads, supplied with mtg. strap, Astron Minimite MM-1000-6 | 1 |
| | 3475-87 | CONNECTOR: male, 24 contact, Elco Vari-con #RM22420-5 | 1 |
| | 6050-23 | FEET: rubber, Philpott Cat. #BH-2095-W | 8 |
| | 8330-8 | HANDLE: for case, Specialty Leather. Consists of: 8330-11 Strap (1), 8220-12 Holder (2), 8330-13 Clamp-spring (2), 8330-14 Support (2) | 1 |
| | 16277-2 | PIN STRAIGHTENER: 9 pin #D9, Duro Specialty Co. | 1 |
| | 16277-3 | PIN STRAIGHTENER: 7 pin #D7, Duro Specialty Co. | 1 |
| R-149 | 16925-244 | POTENTIOMETER: 10,000 ohms, 2 watt, wire wound, 3/8" bushing, 5/8" shaft FMS, screw driver slot, Chicago Telephone type 252 (neg. bias adj.) | 1 |
| R-155 | 16925-287 | POTENTIOMETER: 500 ohms, 2 watt, wire wound, 3/8" bushing, 5/8" shaft FMS, screw driver slot, Chicago Telephone type 252 (sig. amplitude) | 1 |
| R-401 | 16925-288 | POTENTIOMETER: 2 ohms, wire wound, 2 watt 3/8" bushing, 5/8" shaft FMS, screw driver slot, Chicago Telephone type 252 (GM Bal. HI Current) | 1 |
| R-152 | 16925-289 | POTENTIOMETER: 50 ohms, 2 watt, wire wound, 3/8" bushing length, 5/8" shaft FMS, screw driver slot, Chicago Telephone type 252 (Sig. Reg.) | 1 |
| R-311 | 16925-358 | POTENTIOMETER: 100 ohms, 2 watt, wire wound, 3/8" bushing, 5/8" shaft FMS, Chicago Telephone type 252 (Meter Cal.) | 1 |
| R-148 | 40100-503 | POTENTIOMETER: 50,000 ohms, linear, carbon 2 watt, screw driver slot, 3/8" bushing, 7/8" shaft FMS, Allen Bradley type J (Main B+ volt adj.) | 1 |
| R-405 | 40300-252 | POTENTIOMETER: 2500 ohms, linear, carbon, 1/2 watt, Centralab type 2, 3/8" bushing, 7/8" shaft FMS (GM Bridge Bal. - Lo Ib) | 1 |
| R-142 | 40300-503 | POTENTIOMETER: 50K ohms, linear, carbon, 1/2 watt, Centralab type 2, 3/8" bushing, 7/8" shaft FMS (Aux. B+ Control) | 1 |
| R-323, R-136 | 40400-253 | POTENTIOMETER: 25K ohms, .2 watt, linear, carbon, 3/8" shaft, 1/4" bushing, Chicago Telephone type 70 (Fil. Std Cal. - Pos. Bias Adj.) | 2 |
| R-135 | 40400-255 | POTENTIOMETER: 2.5 megohms, .2 watt, linear, carbon, 3/8" shaft, 1/4" bushing, Chicago Telephone type 70 (SH test low Sens.) | 1 |
| R-315 | 40400-503 | POTENTIOMETER: 50,000 ohms, .2 watt, linear, carbon, 3/8" shaft, 1/4" bushing, Chicago Telephone type 70 (SH test High Sens.) | 1 |
| CR-103 | 18150-61 | RECTIFIER: selenium, full-wave bridge, Int. Rect. Part No. 59-1028 | 1 |
| CR-101, CR-102 | 18150-53 | RECTIFIER: selenium, Radio Receptor 20 J7, 65 ma, 320 VRMS, 900 V. PIV | 2 |

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| R-109 | 40500-254 | POTENTIOMETER: 250K ohms, linear, carbon, 1/2 watt, Centralab Model 2, snap-in type (6CD6) (Screen Adj.) | 1 |
| R-123 | 40500-503 | POTENTIOMETER: 50K ohms, linear, carbon, 1/2 watt, Centralab Model 2, snap-in type (Main B-Feed-back Current Adj.) | 1 |
| R-241 | 18537-162 | RESISTOR, deposited film: 1.067K ohms, 1% 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-211 | 18537-69 | RESISTOR, deposited film: 80 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-209 | 18537-70 | RESISTOR, deposited film: 320 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-208 | 18537-71 | RESISTOR, deposited film: 640 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-207 | 18537-72 | RESISTOR, deposited film: 1280 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-206 | 18537-73 | RESISTOR, deposited film: 25,344 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-320 | 18537-88 | RESISTOR, deposited film: 3 megohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-230 | 18539-8 | RESISTOR, deposited film: 100,000 ohms, 1%, 1 watt, Electra DC1, marked with part number and value | 1 |
| R-145 | 18575-150 | RESISTOR, 5000 ohms, 10W, 3/16" ID, 5/16" OD, 1-3/4" long, Lectrohm | 1 |
| R-226 | 18575-164 | RESISTOR, wire wound: 1000 ohms, 1%, 35 watt, Lectrohm, silicone ceramic | 1 |
| R-214, R-218 | 18575-169 | RESISTOR: 10 ohms, 4 watt, 1%, 5/16" x 1", Lectrohm | 2 |
| R-158 | 18410-101 | RESISTOR: 10 ohms, 1/2 watt, 5% | 1 |
| R-213, R-217 | 18575-170 | RESISTOR: 20 ohms, 4 watt, 1%, 5/16" x 1" Lectrohm | 2 |
| R-216 | 18575-171 | RESISTOR: 30 ohms, 4 watt, 1%, 5/16" x 1" Lectrohm | 1 |
| R-215 | 18575-172 | RESISTOR: 40 ohms, 4 watt, 1%, 5/16" x 1" Lectrohm | 1 |
| R-160 | 18431-101 | RESISTOR: 100 ohms, 2 watt, 5% | 1 |
| R-201 | 18575-173 | RESISTOR: 100 ohms, 10 watt, 20%, Center-tapped, 1%, Lectrohm | 1 |
| R-219 | 18575-179 | RESISTOR: 100 ohms, W.W., 1%, 200 MA, buffed for vert. mtg. | 1 |
| R-220 | 18575-180 | RESISTOR: 200 ohms, W.W., 1%, 200 Ma, buffed for vert. mtg., Lectrohm silicone ceramic | 1 |
| R-221 | 18575-181 | RESISTOR: 300 ohms, wire wound, 1%, 200 MA buffed for vert. mtg., Lectrohm | 1 |
| R-222 | 18575-182 | RESISTOR: 400 ohms, wire wound, 1%, 200 MA buffed for vert. mtg., Lectrohm | 1 |
| R-225 | 18575-183 | RESISTOR: 2000 ohms, wire wound, 1%, 100 MA max., Lectrohm, ends buffed for vert. mtg. | 1 |

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| R-224 | 18575-184 | RESISTOR: 3000 ohms, wire wound, 1%, 67 MA | 1 |
| R-223 | 18575-185 | RESISTOR: wire wound, 4000 ohms, 1%, 50 MA | 1 |
| R-146 | 18575-234 | RESISTOR: wire wound, 2000 ohms, 10%, 5 watt, Lectrohm XC5-2000 or equiv. | 1 |
| R-153, R-156 | 18410-331 | RESISTOR: fixed, composition, 33 ohms, 5%, 1/2 watt, Allen Bradley type EB | 2 |
| R-205 | 18410-271 | RESISTOR: fixed, composition, 27 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| R-203 | 18411-221 | RESISTOR: fixed, composition, 220 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| | 18412-101 | RESISTOR: fixed, composition, 1000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| R-402, R-403 R-404, R-406 | 18413-101 | RESISTOR: fixed, composition, 10,000 ohms, 5% 1/2 watt, Allen Bradley type EB | 4 |
| R-147 | 18413-241 | RESISTOR: fixed, composition, 24,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| R-143, R-120 | 18413-301 | RESISTOR: fixed, composition, 30,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 2 |
| | 18413-271 | RESISTOR: fixed, 27,000 ohms, 5%, 1/2 watt | 1 |
| R-322, R-139 | 18413-331 | RESISTOR: fixed, composition, 33,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 2 |
| R-110, R-114, R-308, R-314, R-140 | 18414-101 | RESISTOR: fixed, composition, 100,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 5 |
| R-316 | 18414-151 | RESISTOR: fixed, composition, 150,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| R-309 | 18414-201 | RESISTOR: fixed, composition, 200,000 ohms, 5%, 1/2 watt, Allen Bradley type EB | 1 |
| R-303, R-304, R-305, R-306, R-307 | 18415-201 | RESISTOR: fixed, composition, 2 megohms, 5%, 1/2 watt, Allen Bradley type EB | 6 |
| | 18416-201 | RESISTOR: fixed, composition, 20 megohms, 5%, 1/2 watt | 1 |
| R-162 | 18422-682 | RESISTOR: fixed, composition, 6800 ohms, 10%, 1 watt, Allen Bradley type GB | 1 |
| R-227, R-228, R-231 | 18433-201 | RESISTOR: fixed, composition, 20,000 ohms, 5%, 2 watt, Allen Bradley type HB | 3 |
| R-229 | 18433-301 | RESISTOR: fixed, composition, 30,000 ohms, 5%, 2 watt, Allen Bradley type HB | 1 |
| R-210 | 18537-31 | RESISTOR: deposited film, 160 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-238 | 18537-47 | RESISTOR: deposited film, 10,000 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-239, R-240 | 18537-48 | RESISTOR: deposited film: 20,000 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 2 |
| R-212 | 18537-68 | RESISTOR: deposited film, 40 ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| R-112 | 18537-26 | RESISTOR: deposited film, 100,000 ohm, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |

# ERRATA SHEET

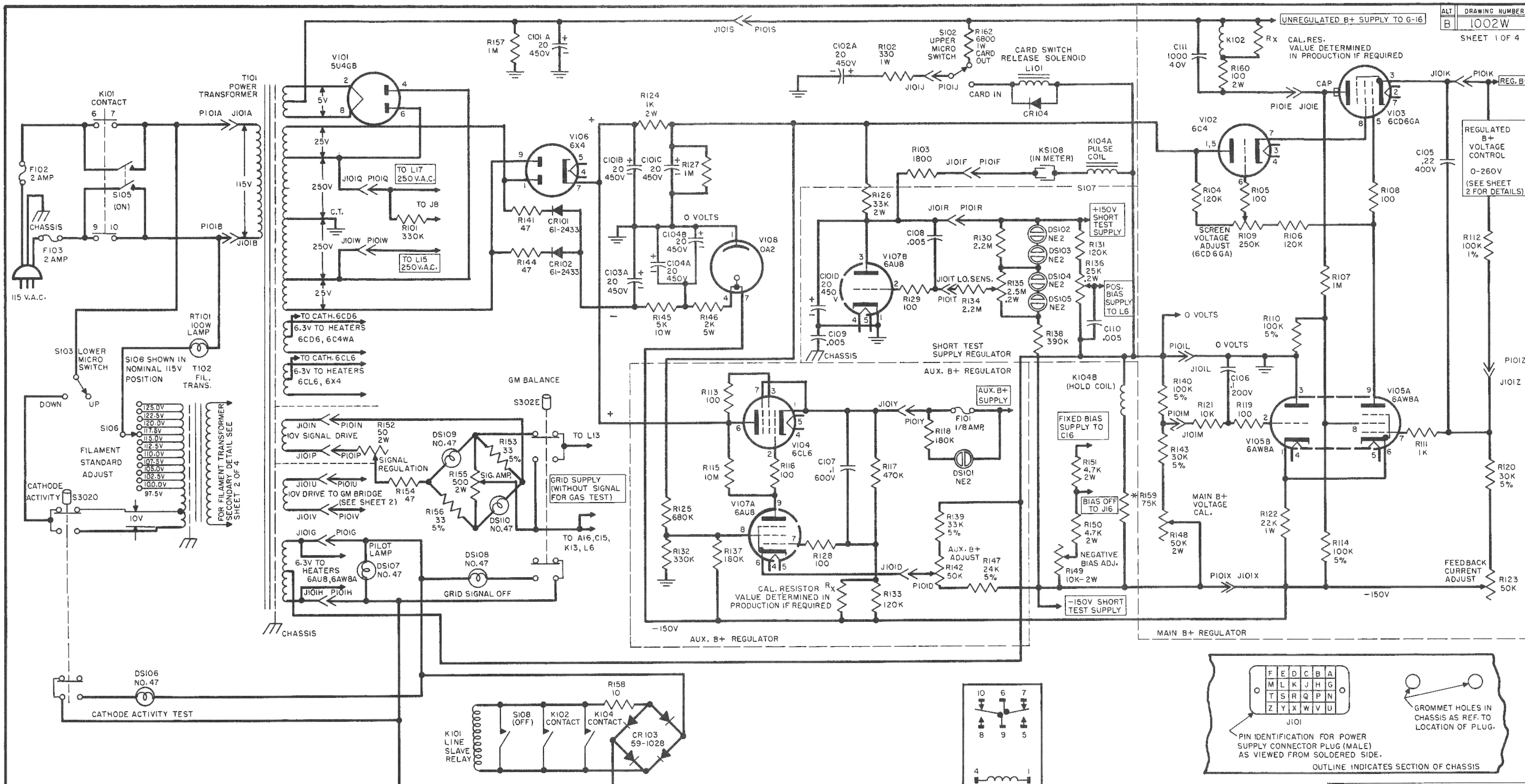
MODEL KS-15874-L2
with Serial Numbers Above 900

## PARTS LIST

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| | | **DELETE** | |
| S-105 | 19910-160 | SWITCH: ON-Carling 216-PCFF-C-BL-4 | 1 |
| | | **ADD** | |
| S-105 | 19910-164 | SWITCH: ON, DPST, momentary push, normally open. A. H. and H. No. 3594Q. | 1 |
| | 2920-17 | BUTTON: molded, push, black phenolic. A. H. and H. No. 3391-194B. Use with Hickok part No. 19910-164 | 1 |

Code No. 19120-79

| Reference Symbol | Hickok Code No. | Description | Quan. Req. per Unit |
|---|---|---|---|
| R-234 thru R-236 | 18537-164 | RESISTOR: deposited film, 52K ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 3 |
| R-237 | 18537-165 | RESISTOR: deposited film, 62K ohms, 1%, 1/2 watt, Electra DC1/2A, marked with part number and value | 1 |
| *R-159 | 18413-751 | RESISTOR: calibration resistor, nom. value 75K, exact value determined in manufacture | 1 |
| S-301 | 19910-137 | SWITCH: push button, Oak #94889-130 | 1 |
| S-302 | 19910-139 | SWITCH: push button, auxiliary function | 1 |
| S-106 | 10012-399 | SWITCH: rotary, 1 section, 12 pos. Fil. Adjust | 1 |
| T-102 | 20800-227 | TRANSFORMER: filament | 1 |
| T-101 | 20800-228 | TRANSFORMER: power | 1 |
| L-101 | 19360-3 | SOLENOID | 1 |
| S-102 | 19910-145 | SWITCH: push button type, Electro-snap E4-109 | 1 |
| S-103 | 19910-112 | SWITCH: push button type, Micro V3-26 | 1 |
| S-105 | 19910-160 | SWITCH: ON - Carling 216 - P OFF-C-BL-4 | 1 |
| S-108 | 19910-161 | SWITCH: OFF - Carling 16-3P OFF-CRD-4 | 1 |




RELAY K101 ENERGIZED (BOTTOM VIEW)

NOTES:

1. ZERO VOLTS COMMON ON POWER SUPPLY = ⏚
2. UNLESS OTHERWISE SPECIFIED RESISTORS ARE ±10%, 1/2W AND SHOWN IN OHMS. K = 1,000 M = 1,000,000
3. CAPACITANCES ARE IN MICROFARADS.
4. TRANSFORMER VOLTAGES ARE GIVEN IN R.M.S. VALUES.
5. ✱ CALIBRATION RESISTORS: NOMINAL VALUE, EXACT VALUE DETERMINED IN MANUFACTURE.
6. ┼ = CONNECTION, ⌒ = NO CONNECTION

| NO. | ALTERATION | BY | APP'D | DATE |
|---|---|---|---|---|
| B | 25146 | ER |  | 3-29-62 |
| A | 25133 | TR |  | 3-20-62 |

| | | | |
|---|---|---|---|
| SCHEMATIC WIRING DIAGRAM - KS-15874-L2 | | | |
| TUBE TESTER (SERIAL NO.S ABOVE 900) | | | |
| DRAWN & TRACED | CHECKED | APP'D | DATE |
| T. BERG | | | 12-20-61 |

SHEET 1 OF 4

DRAWING NUMBER 1002W

THE HICKOK ELECTRICAL INSTRUMENT CO.
CLEVELAND, OHIO

ALT B | DRAWING NUMBER 1002W

SHEET 1 OF 4

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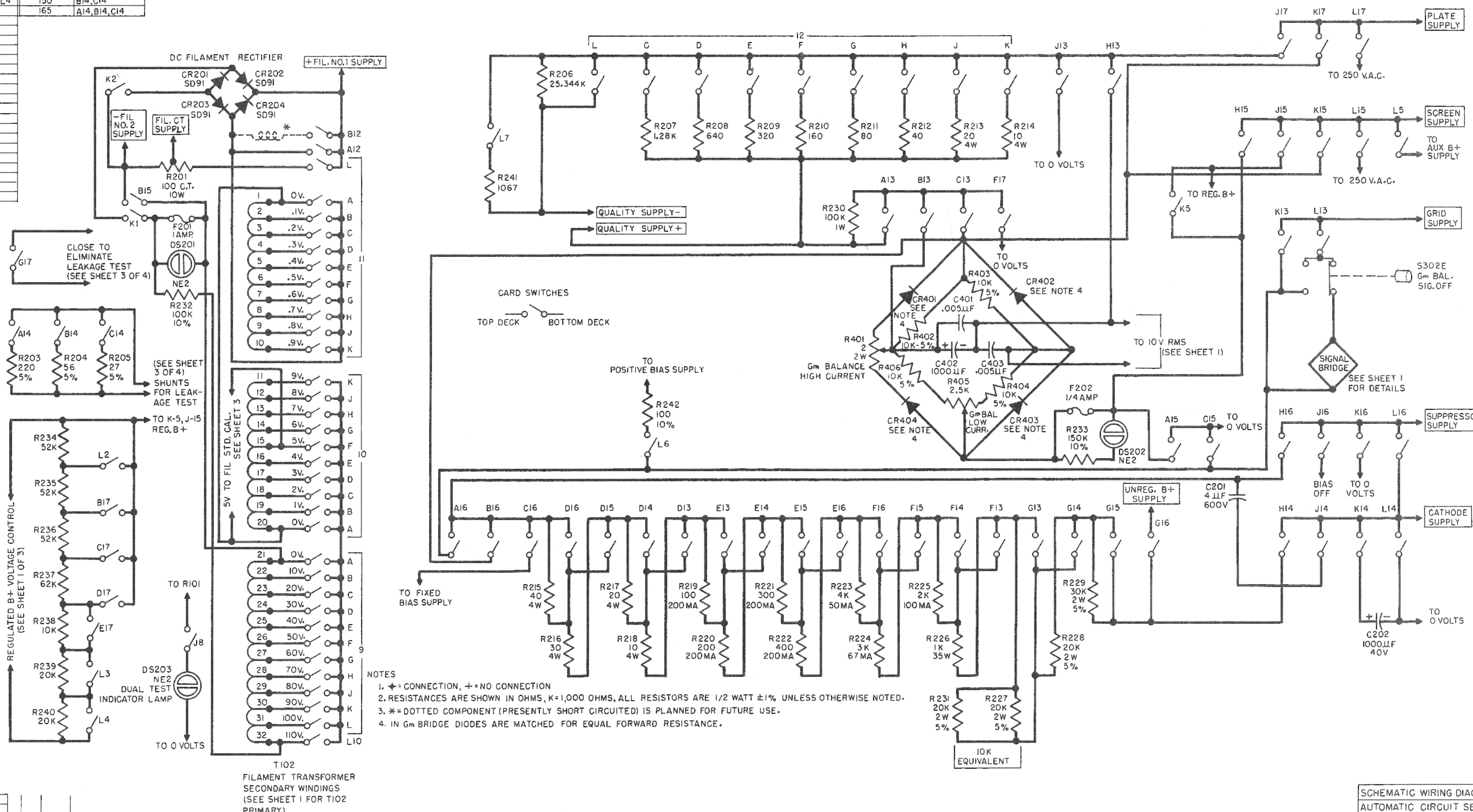
| ALT. | DRAWING NUMBER |
|---|---|
| B | 1002W |

SHEET 2 OF 4

| B+ OUTPUT VOLTS | CLOSE |
|---|---|
| 10 | D17, L3, L4 |
| 20 | D17, E17, L4 |
| 30 | D17, L4 |
| 40 | D17, E17 |
| 50 | D17 |
| 60 | C17, E17, L3, L4 |
| 70 | C17, L3, L4 |
| 80 | C17, E17, L4 |
| 90 | C17, L4 |
| 100 | C17, E17 |
| 110 | C17 |
| 120 | B17, L3, L4 |
| 130 | B17, E17, L4 |
| 140 | B17, L4 |
| 150 | B17, E17 |
| 160 | B17 |
| 170 | L2, L3, L4 |
| 180 | L2, E17, L4 |
| 190 | L2, L4 |
| 200 | L2, E17 |
| 210 | L2 |
| 220 | L3, L4 |
| 230 | E17, L4 |
| 240 | L4 |
| 250 | E17 |
| 260 | NONE |

| LEAKAGE REJECT | CLOSE |
|---|---|
| 10µA | NO A14, B14, C14 |
| 20 | A14 |
| 50 | B14 |
| 70 | A14, B14 |
| 100 | C14 |
| 150 | B14, C14 |
| 165 | A14, B14, C14 |




NOTES
1. ✚= CONNECTION, + = NO CONNECTION
2. RESISTANCES ARE SHOWN IN OHMS, K=1,000 OHMS, ALL RESISTORS ARE 1/2 WATT ±1% UNLESS OTHERWISE NOTED.
3. ✱= DOTTED COMPONENT (PRESENTLY SHORT CIRCUITED) IS PLANNED FOR FUTURE USE.
4. IN Gm BRIDGE DIODES ARE MATCHED FOR EQUAL FORWARD RESISTANCE.

| NO. | ALTERATION | BY | APP'D | DATE |
|---|---|---|---|---|
| B | 25146 | ER | | 3 29 62 |
| A | 25130 | TB | | 3 20 62 |

SCHEMATIC WIRING DIAGRAM-KS-15874-L2
AUTOMATIC CIRCUIT SELECTION

| DRAWN & TRACED | CHECKED | APP'D | DATE |
|---|---|---|---|
| T. BERG | | | 12-29-61 |

SHEET 2 OF 4
DRAWING NUMBER 1002W

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CLEVELAND, OHIO

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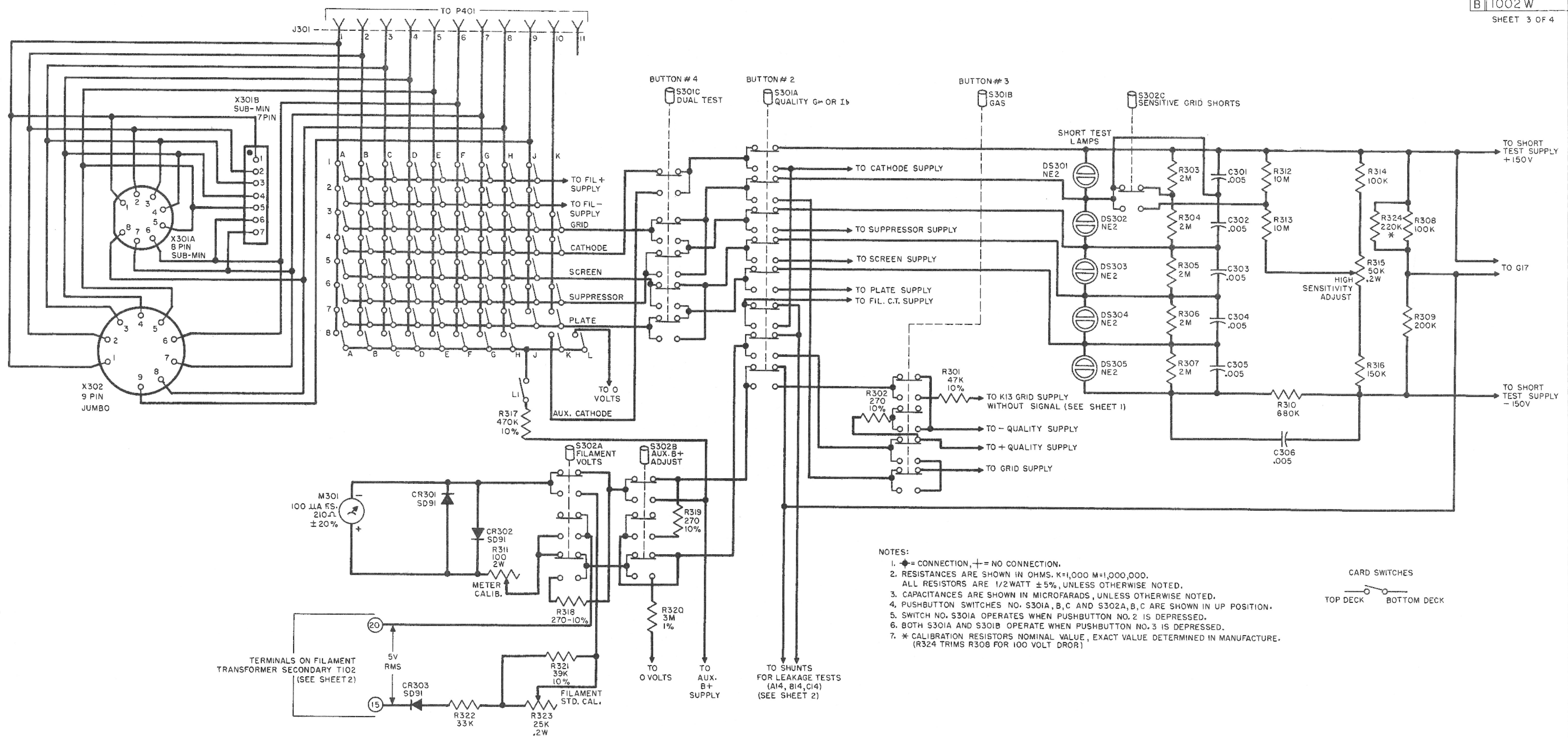


NOTES:

1. ✦ = CONNECTION, ┼ = NO CONNECTION.
2. RESISTANCES ARE SHOWN IN OHMS. K=1,000 M=1,000,000. ALL RESISTORS ARE 1/2 WATT ±5%, UNLESS OTHERWISE NOTED.
3. CAPACITANCES ARE SHOWN IN MICROFARADS, UNLESS OTHERWISE NOTED.
4. PUSHBUTTON SWITCHES NO. S301A, B, C AND S302A, B, C ARE SHOWN IN UP POSITION.
5. SWITCH NO. S301A OPERATES WHEN PUSHBUTTON NO. 2 IS DEPRESSED.
6. BOTH S301A AND S301B OPERATE WHEN PUSHBUTTON NO. 3 IS DEPRESSED.
7. * CALIBRATION RESISTORS NOMINAL VALUE, EXACT VALUE DETERMINED IN MANUFACTURE. (R324 TRIMS R308 FOR 100 VOLT DROP)

| NO. | ALTERATION | BY | APP'D | DATE |
|---|---|---|---|---|
| B | 25146-R310 WAS 330 K | ER | | 3-29-62 |
| A | 25130 | TB | | 3-20-62 |

SCHEMATIC WIRING DIAGRAM-KS-15874-L2
TUBE TESTER

| DRAWN & TRACED | CHECKED | APP'D | DATE |
|---|---|---|---|
| T. BERG | | | 12-21-61 |

SHEET 3 OF 4
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THE HICKOK ELECTRICAL INSTRUMENT CO.
CLEVELAND, OHIO

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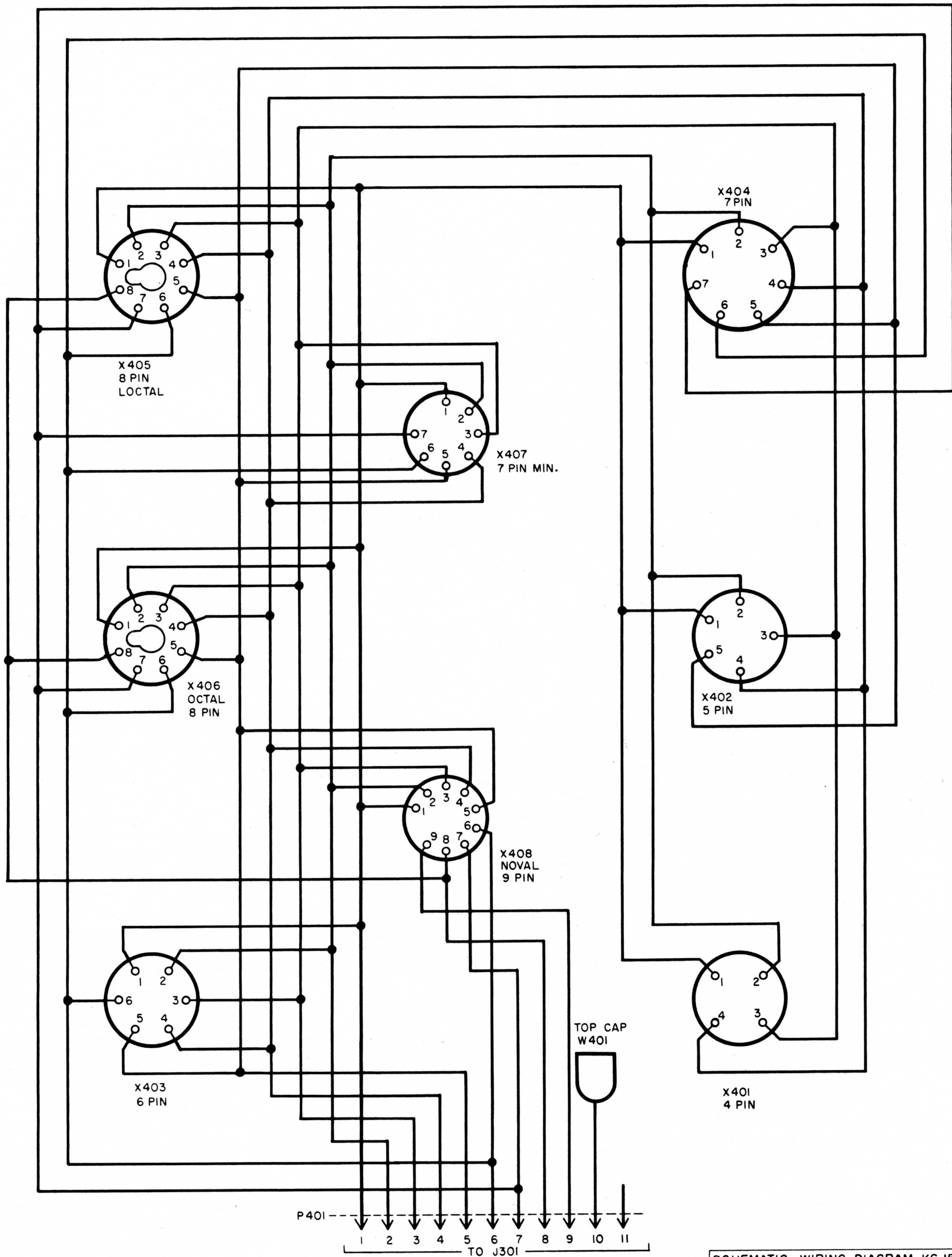
| B | 1002W |

SHEET 4 OF 4




| NO. | ALTERATION | BY | APP'D | DATE |
|---|---|---|---|---|
| B | 25146 | ER | | 3·29·62 |
| A | 25130 | TB | | 3·20·62 |

SHEET 4 OF 4

| DRAWING NUMBER |
|---|
| 1002 W |

SCHEMATIC WIRING DIAGRAM-KS-15874-L2

REPLACEABLE TUBE SOCKET PLATE

| DRAWN & TRACED | CHECKED | APP'D | DATE |
|---|---|---|---|
| T. BERG | | | 12-15-61 |

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